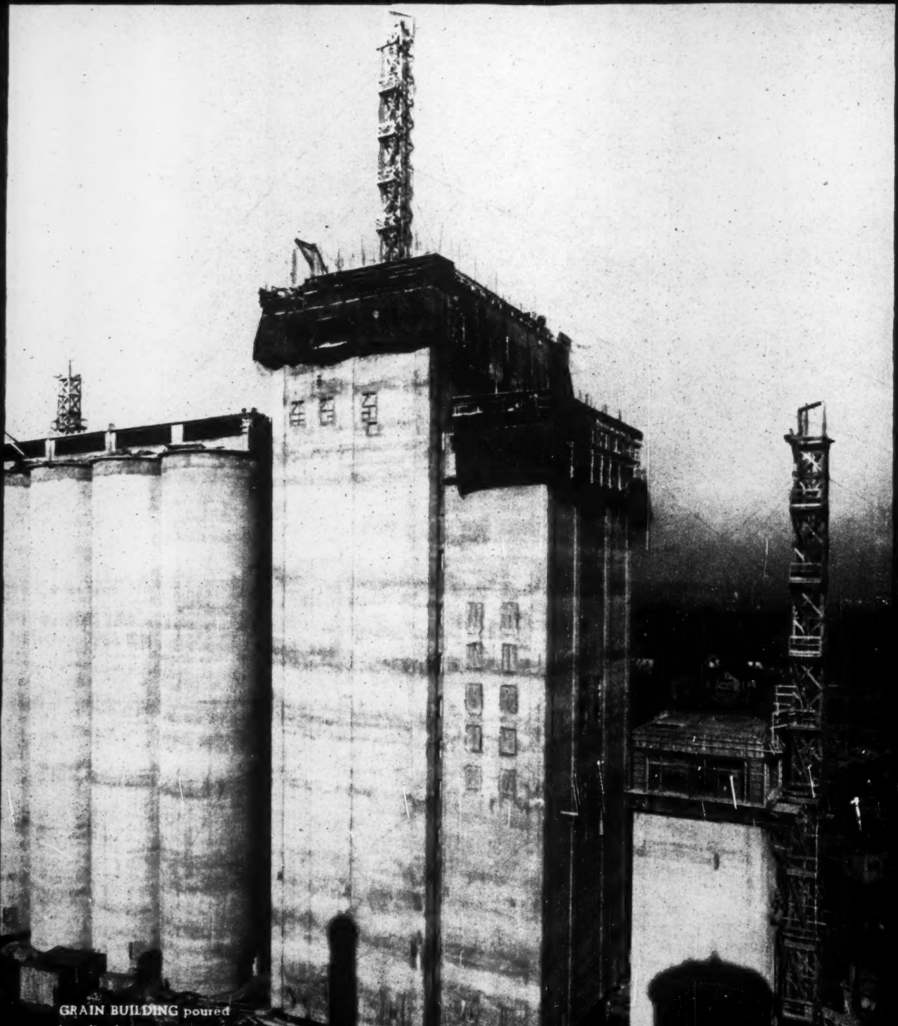
CIVIL ENGINEERING



GRAIN BUILDING poured by slip form rises 165 ft in 11 days. Macdonald

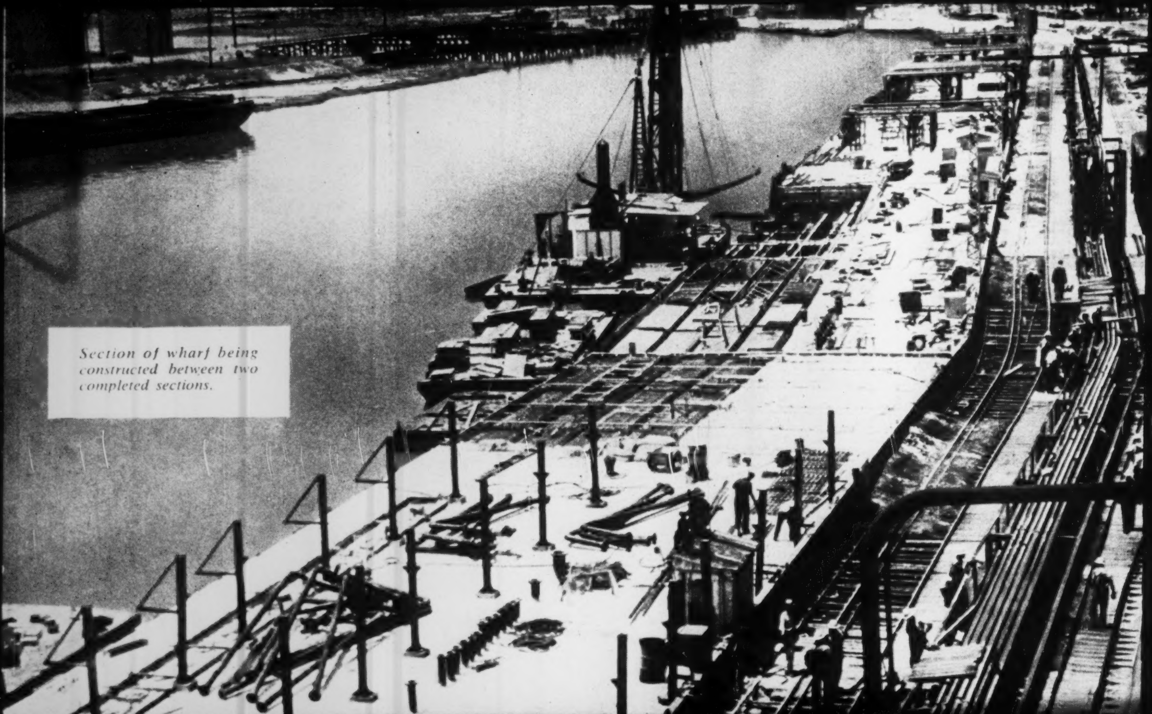
AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

RAYMOND

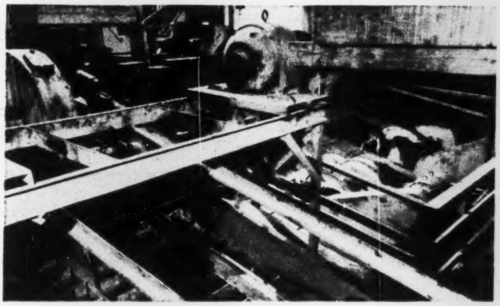
SERVING GULF OIL FOR 40 YEARS

THROUGH THE YEARS, [illegible]

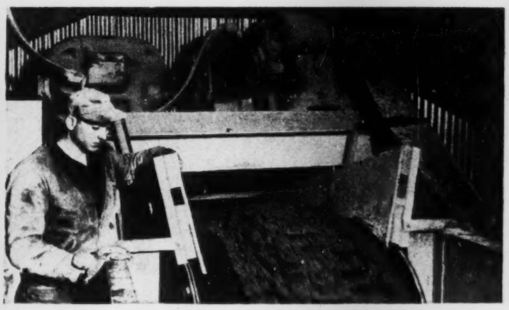
RAYMOND



Section of wharf being constructed between two completed sections.

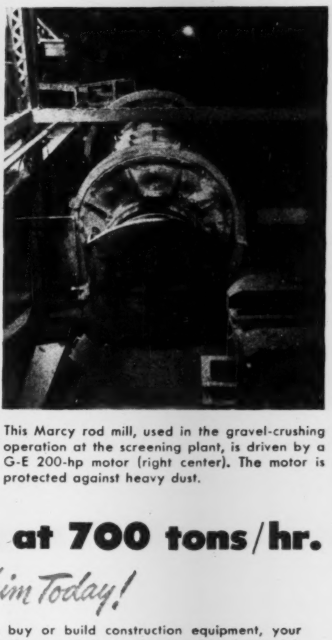


Aggregate under 6 inches is separated in shakers at screening plant. A G-E 5-hp motor drives shakers. Plant is completely automatic.



Carrying cement mix along this indoor conveyor system is a crucial step in construction of the dam. Sturdy G-E 100-hp motor drives the belt.

Aggregate for batching plant at Hungry Horse Dam is carried 1600 feet up the canyon wall by conveyor, driven by reliable G-E 100-hp motors in wooden sheds at intervals of 250 to 300 feet.



This Marcy rod mill, used in the gravel-crushing operation at the screening plant, is driven by a G-E 200-hp motor (right center). The motor is protected against heavy dust.

push-button aggregate processing at 700 tons/hr.

. . . Electrically

General-Shea-Morrison, contractors for the Bureau of Reclamation's Hungry Horse Dam, are going all-out with electric equipment. Best example is their aggregate plant with its network of interconnecting conveyors geared to process 700 tons of raw aggregate every hour. It's one of the most modern installations of its kind in the country—strictly a push-button operation from raw aggregate handling to mixing. Only with modern electric drives can this world's fourth largest dam be completed on schedule in 1952.

As time goes on, contractors are discovering more and more that it pays to electrify. With co-ordinated use of G-E motors and control and G-E power-distribution systems, they're getting safer, more flexible, and more efficient operation. *Apparatus Department, General Electric Company, Schenectady 5, N.Y.*

Ask him Today!

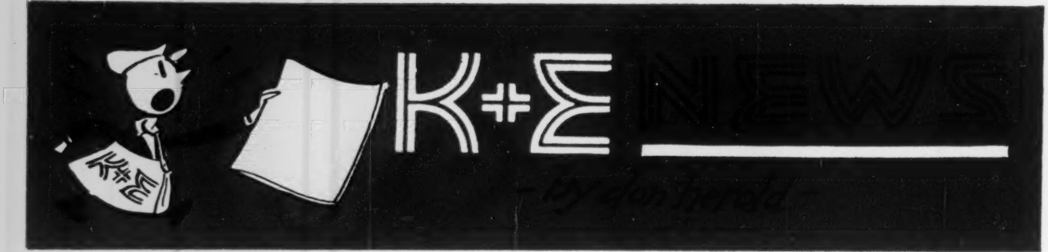
Whether you buy or build construction equipment, your G-E representative can show you how to do a better job —at lower cost—by complete electrification. Write him now, and he'll call on you at your convenience.

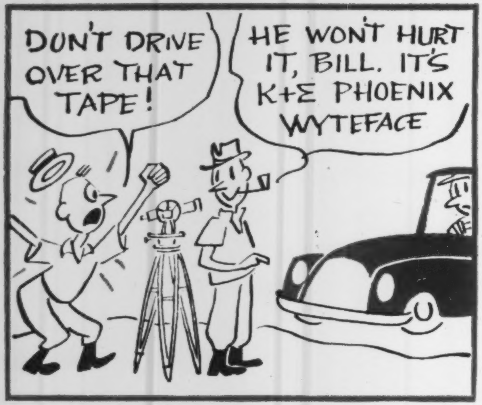
ELECTRIFIED EQUIPMENT
**Speeds Construction—
Cuts Costs**

GENERAL ELECTRIC

664-16

CIVIL ENGINEERING, The Magazine of Engineered Construction, March, 1951. Vol. 21, No. 3. Published monthly by the American Society of Civil Engineers. Publication office 20th and Northampton Streets, Easton, Pa. Editorial and advertising departments at the headquarters of the Society, 33 West 39th Street, New York, N. Y. Price 50¢ a copy, $5.00 a year in advance, $4.00 a year to members and to libraries and $2.50 a year to members of Student Chapters. Canadian postage 75¢ and foreign postage $1.50 additional. Entered as second class matter September 23, 1930, at the Post Office, Easton, Pa., under the Act of August 24, 1912, and accepted for mailing at a special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on July 5, 1918.




DON'T DRIVE OVER THAT TAPE!
HE WON'T HURT IT, BILL. IT'S K+E PHOENIX WYTEFACE

tape that can take it

You don't exactly buy tape to kick it around,

BUT—

—BUT you'll have to admit that most woven tapes do have to take an awful beating. For years nobody has come up with a better answer than "metallic" woven tapes—with little strands of metal woven into them.

BUT here's something far better—PHOENIX WYTEFACE† *non-metallic* Woven Tapes—a great and radical forward stride in tape development.

As one highway engineer puts it: *"it has at least three times the life of ordinary metallic tapes."*

PHOENIX WYTEFACE has been given the works in grueling field tests—in extremes of climate, in water and mud, over stones and rocks, under truck wheels, through brush and barbed wire—and has come through shining and unscathed.

The secret is, this tape is a weave of amazingly strong synthetic yarns—a scientific wartime development—completely covered by an armor-like plastic coating that is not affected by water, is not brittle, will not flake.

MORE ACCURATE, TOO

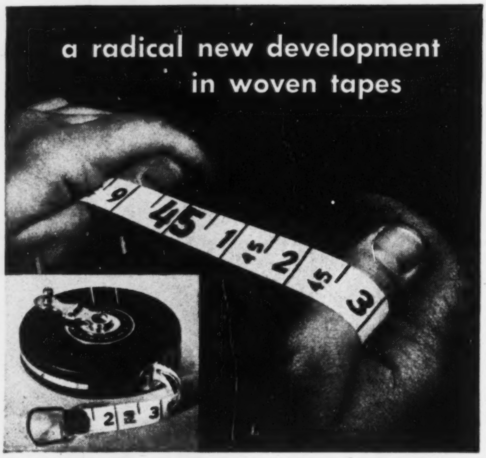
Even after repeated soaking and dryings, this tape won't let you down. It has dimensional stability a lot greater than so-called "metallic" woven tapes.

And it has a HIGHER DIELECTRIC CONSTANT—which is important to power and utility companies and to anyone working near high tension circuits.

The clear black and red markings on the white background almost read themselves out loud, and the surface easily wipes clean as a whistle.

†Trade Mark. U. S. Pat. 2,321,920.

PHOENIX WYTEFACE



LOOK! LETTERING WITH MY EYES SHUT (ALMOST) - WITH THE LEROY!
NOW IS THE

beautiful lettering with little effort

Many engineers make perfect drawings and then mess them up with "home made" lettering. A quick easy way to get lettering and symbols which look like type on your drawings is to use a LEROY* "controlled lettering" outfit, a Keuffel & Esser Co. product.

THE MAN WHO HAND LETTERED THIS LINE

DID THIS WITH A LEROY LETTERING SET.

And he had had little experience with LEROY, and it took him no more time.

He didn't even have to rough it in with a pencil or draw guide lines. He chose one of several alphabets (templates) in his kit and followed the character grooves with an easy stroke of the scriber. Then the pen formed perfect letters right where he wanted 'em. A blind man could darned near do it!

LEROY lettering is free from risk of smearing, because the template is well removed from the lettering, and, there's no need for erasing. You have a wide choice of sizes and types of lettering, numerals and symbols.

COME ON, ALBANENE!
K&E
YEARS

a tracing paper for the ages

You practically want to think of posterity when you buy tracing paper. Well, there are drawings around today that were made years and years ago on ALBANENE*, and they are today as crisp and sharp as you could ask—which proves that ALBANENE does not turn brittle or lose its transparency with time.

You see, ALBANENE's transparency is due not to oils that leak and "bleed", but to a synthetic transparentizer that K&E developed specially for this purpose—and not for flavoring popcorn.

*Trade Mark®

Ask your K&E Distributor or Branch for further information on any of these fine products, or for a sample length of PHOENIX WYTEFACE. Or write to Keuffel & Esser Co., Hoboken, N. J.

K+E

partners in creating

For 83 years K&E equipment and materials have been partners of the draftsman, engineer and scientist in shaping the modern world.

KEUFFEL & ESSER CO.

EST. 1867

Drafting, Reproduction, Surveying Equipment and Materials. Slide Rules, Measuring Tapes

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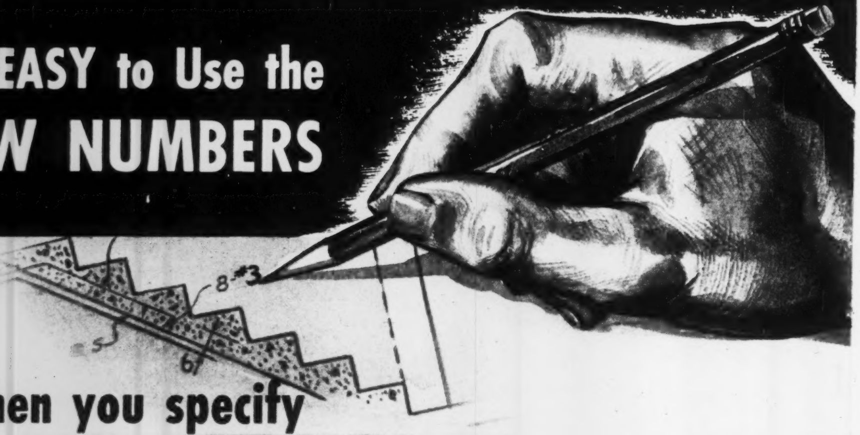
It's EASY to Use the NEW NUMBERS



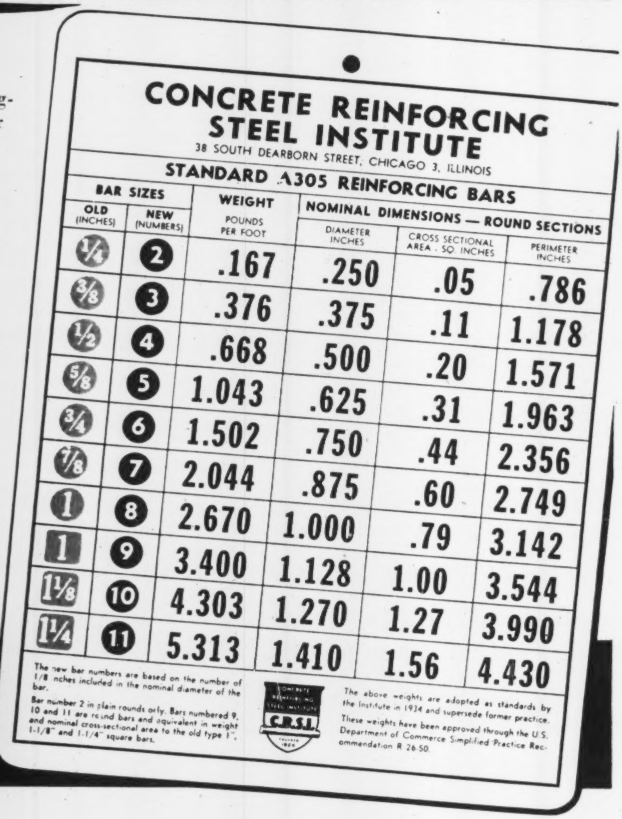
When you specify

A305 *IMPROVED* REINFORCING BARS

For years it has been customary to designate the size of reinforcing bars by their diameter—¼", ⅜", etc. Square bars were designated by the width of one side.

Now, with the improved A305 bars, numbers from 2 to 11 are used to designate bar sizes. These numbers denote the nominal diameter of the bar in eighths of an inch. However, as the new bars have the same cross-sectional area as the old bars, design tables do not need to be changed. The #3 bar, for example (nominal diameter ⅜") has the same weight per foot as a ⅜" plain round bar. Bars #9, #10, and #11 are round bars equivalent in weight and nominal cross-sectional area to the former 1", 1⅛", and 1¼" square bars.

The accompanying bar chart explains these new designations.



CONCRETE REINFORCING STEEL INSTITUTE
38 SOUTH DEARBORN STREET, CHICAGO 3, ILLINOIS

STANDARD A305 REINFORCING BARS

BAR SIZES		WEIGHT	NOMINAL DIMENSIONS — ROUND SECTIONS		
OLD (INCHES)	NEW (NUMBERS)	POUNDS PER FOOT	DIAMETER INCHES	CROSS SECTIONAL AREA - SQ. INCHES	PERIMETER INCHES
¼	2	.167	.250	.05	.786
⅜	3	.376	.375	.11	1.178
½	4	.668	.500	.20	1.571
⅝	5	1.043	.625	.31	1.963
¾	6	1.502	.750	.44	2.356
⅞	7	2.044	.875	.60	2.749
1	8	2.670	1.000	.79	3.142
1	9	3.400	1.128	1.00	3.544
1⅛	10	4.303	1.270	1.27	3.990
1¼	11	5.313	1.410	1.56	4.430

The new bar numbers are based on the number of 1/8 inches included in the nominal diameter of the bar.

Bar number 2 in plain rounds only. Bars numbered 9, 10 and 11 are round bars and equivalent in weight and nominal cross-sectional area to the old type 1", 1-1/8" and 1-1/4" square bars.

C.R.S.I.

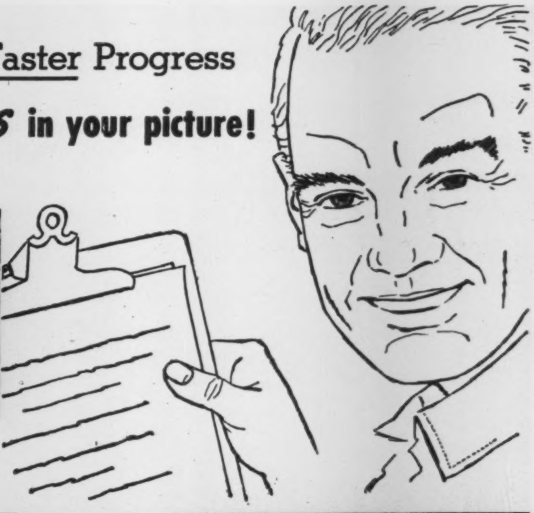
The above weights are adopted as standards by the Institute in 1934 and supersede former practice.

These weights have been approved through the U.S. Department of Commerce Simplified Practice Recommendation R 26-50.

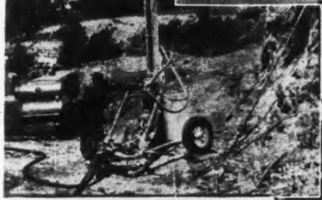
Write for your FREE Copy of this New Bar Card

CONCRETE REINFORCING STEEL INSTITUTE • 38 S. Dearborn St., Chicago 3

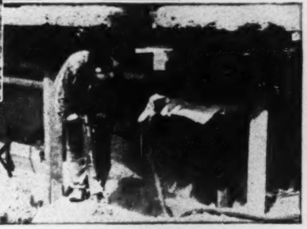
Progress Reports Reveal Faster Progress
when *Gardner-Denver's* in your picture!



Air pressure's always up —when Gardner-Denver Portables feed your lines. Cylinders are water-cooled *all* the way down for all weather efficiency—compressors are two-stage for any altitude performance.



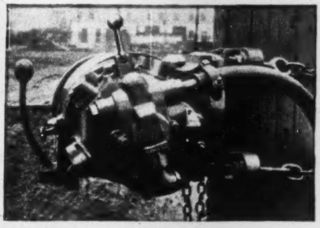
Holes are spotted quickly—drilled fast and clean with Gardner-Denver Wagon Drills.



Demolition proceeds at a steady pace—Gardner-Denver Breakers are easy on the operator—tough on concrete.

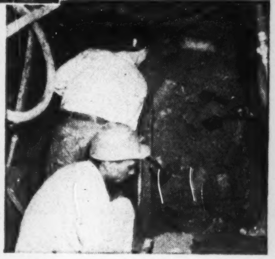
A clean hole drills faster — and Gardner-Denver Sinkers are noted for hole cleaning ability, powerful rotation.

Packs backfill swiftly and firmly—Gardner-Denver Tampers are easy to hold—seldom require maintenance—non-freezing.

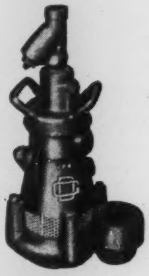


For speedy pull and haul—powerful Gardner-Denver Air Hoists are easy to control.

Saves shop time for all pneumatic tools—L012 Automatic Oiler shuts off air when it runs out of oil.



Clay or hardpan doesn't waste time—when tackled with Gardner-Denver Clay Spaders and Trench Diggers.



Keeps water out of your way—Top-Suction VP4 Sump Pump won't burrow in the mud—keeps grit out of the pump shaft seal.

Write for further information.

SINCE 1859

GARDNER-DENVER

THE QUALITY LEADER IN PUMPS,
COMPRESSORS AND ROCK DRILLS

Gardner-Denver Company, Quincy, Illinois

In Canada:
Gardner-Denver Company (Canada), Ltd., Toronto, Ontario

PULLING A 17-YARD SCRAPER, the TD-24 moves more paydirt in a faster time cycle to keep Highum and Wondra ahead of the contract time clause on Minnesota State Aid Road Number 9, near Clinton Falls, Minnesota.

IT'S "THE CHAMP"—the big red International TD-24—and here's what R. E. Highum says about it: "The easy quick-starting engine gets our equipment working sooner each day. Over a period of time that means a lot more profit for us. Economy in fuel, lubrication, and repairs is good. International parts delivery and service are tops."

Clean, quick shave for the face of Minnesota

How one contractor closes the work-gap with the TD-24

Up in the land of ten thousand lakes, the International TD-24 is doing a job of moving paydirt that would make any contractor sit up and take notice.

Highum and Wondra, Blooming Prairie, Minnesota, on a state road improvement contract, are a hundred percent for International—and here's why:

The TD-24 on the job rolled up 1,500 hours its first year with no downtime and not a cent for repairs.

Quick, all-weather starting—with International's exclusive push-button, gasoline-conversion starting system—gets equipment working sooner each day—doubly important where the snow flies early and stays late.

TD-24 hauls a bigger payload with a shorter time cycle—does more work with more speed.

Synchromesh transmission—you shift "on-the-go."

Planet Power steering with finger-tip control for pivot turns, feathered turns, turns with power on both tracks.

Reserve engine torque control—gives more lugging ability and increased drawbar pull for overloads.

Power—TD-24 delivers 148 maximum horsepower at the drawbar.

Ask the superintendents and the "skinners" on any TD-24 job. Ask to take the controls yourself. Then let your International Industrial Distributor show you what's in the TD-24 for you. You'll be a TD-24 man from then on in.

INTERNATIONAL HARVESTER COMPANY, CHICAGO 1, ILLINOIS

INTERNATIONAL CRAWLERS MAKE SNOW TRAPS—deep snow ditches to keep the highway from drifting over in winter. A TD-9 and two TD-18's are on this job. One TD-18 has 4,500 hours in three years, the other has 9,600 hours in four years!

INTERNATIONAL HARVESTER

INTERNATIONAL

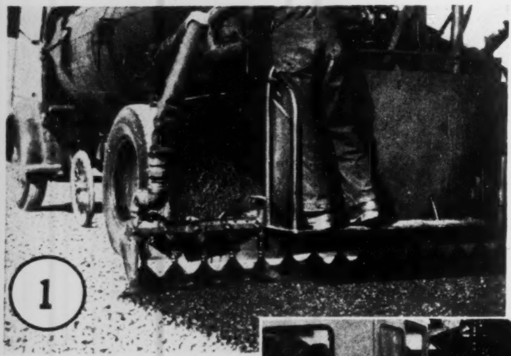
POWER THAT PAYS

3 Types of Paving Built Better

with Bitumuls

REG. U.S. PAT. OFF.

Paving engineers in all parts of the U. S., and in many foreign lands, select BITUMULS—for 3 reasons. It *PENETRATES* throughout interlocked stone without pre-heating. It *MIXES* easily, thoroughly, with damp sands and dense native materials. It *SEALS* with unsurpassed precision.

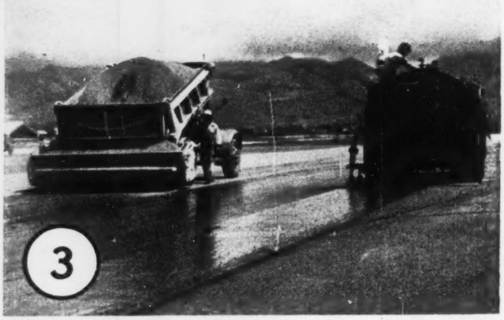


MAINE—

Highway Department engineers have placed over two million sq. yds. of BITUMULS macadam — a standard type of pavement since 1931. They know how thoroughly it penetrates interlocked stone.

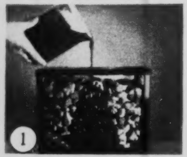
OREGON—

Engineers observe the ease with which BITUMULS mixes with damp native aggregates — and gives early pavement stability. Above is a road near Mount Hood, where crushed aggregate is not readily available.



HONOLULU—

In most highway paving manuals, BITUMULS is a recognized standard for sealing and surface treating. Engineers in Honolulu are no exception—they "shoot" BITUMULS the year 'round.



It PENETRATES

It COATS DAMP NATIVE MATERIALS

It SEALS

Our regional engineers can help you.

In the East
AMERICAN BITUMULS COMPANY
200 BUSH STREET · SAN FRANCISCO 4, CALIF.
Washington 6, D. C. · Baltimore 3, Md. · Perth Amboy, N. J.
Columbus 15, O. · St. Louis 17, Mo. · Baton Rouge 2, La.
Mobile, Ala. · E. Providence 14, R. I. · San Juan 23, Puerto Rico

In the West
STANCAL ASPHALT & BITUMULS COMPANY
200 BUSH STREET · SAN FRANCISCO 4, CALIF.
Los Angeles, Calif. · Oakland 1, Calif.
Portland 4, Ore. · Seattle, Wash. · Tucson, Ariz.

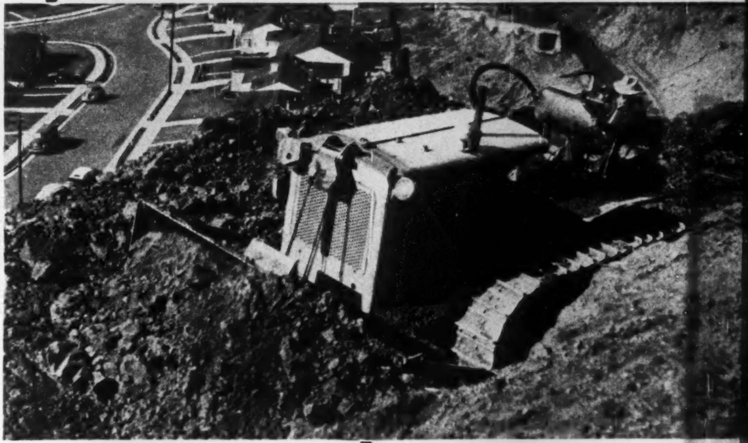
Ask for our BITUMULS BOOKLETS. They are factual, illustrated, and helpful—a valuable addition to your engineering library.

- **Bitumuls Penetration Macadam** ☐
- **Bitumuls for Maintenance** ☐
- **Bitumuls Sand-Mix** ☐
- **Bitumuls Handbook** ☐
- **Hydropel**—Admix for concrete ☐
- **Tennis Courts**—Laykold & Grasstex ☐
- **Fibrecoat**—roof and metal coating ☐

"CAT" BULLDOZER...

America's all-purpose tool!

Owned by John H. McCosker, Inc., Berkeley, Calif., this "Cat" D8 Tractor with No. 8S 'Dozer clears and removes dirt from landslide caused by heavy rains in Oakland, California. Mr. McCosker says of this tool: "One of the finest pieces of equipment that money can buy. Low on repairs, got good traction, and she's easy to handle!" Price of a standard "Caterpillar" D8 Tractor is $15,000; No. 8S Bulldozer, $1,775; No. 25 Cable Control, $1,630, f.o.b. Peoria. Prices subject to change without notice.



THE tool that carved out the streets and leveled building sites is the same "Caterpillar" Bulldozer now protecting the community from landslide hazards. The versatility and long service life of "Cat" 'Dozers make them a prime favorite in the construction field.

These machines give you matched design—tractor and 'dozer are built to work together. This rugged team is a bear at meeting work schedules. Sturdy construction and quality materials enable it to keep punching full time without down-time, and the special steel cutting edge of the blade hammers through the toughest going. Most important of all, the precision methods used in "Caterpillar" factories build extra years of life into these tools.

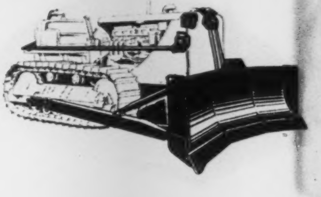
For help with your equipment problems, see your "Caterpillar" dealer *now*. Today's expanding military program has high priority. But it is recognized that our national preparedness depends upon stepped-up civilian production too. We must have more lumber, coal, food and essential ores. We must continue to build and improve America's vital network of highways. So your "Caterpillar" dealer is interested in meeting your needs—through equipment replacement and by exercising his working partnership with you to keep the machinery you have *on the job.*

CATERPILLAR, PEORIA, ILLINOIS

• • •

"CATERPILLAR" BULLDOZER EXTRA FEATURES

1. Tractor and 'dozer *broken to harness*, and a size for every need.
2. Moldboard curvature for active, *rolling*, higher production loads.
3. Box section side arms — extra thick at points of greatest stress.
4. Choice of straight or angling type of blade, simple to maneuver and easy to adjust or detach.
5. Your choice of hydraulic or cable controls.
6. The power of the "Caterpillar" Diesel Engine is geared to blade *capacity*.



New Addition to 'Dozer Line

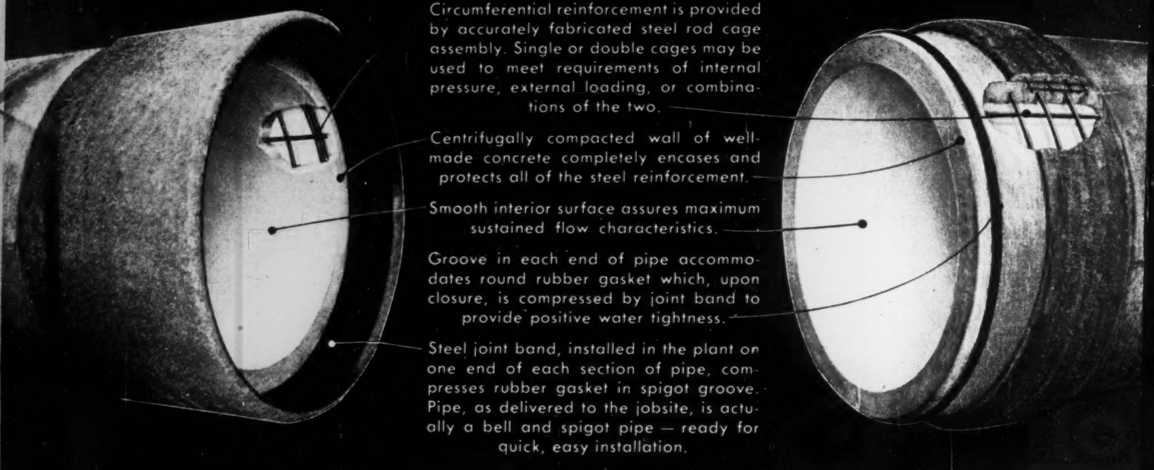
Here's a specialist that can increase production and cut costs. It's the brand new No. 8U 'Dozer for use with the "Caterpillar" D8 Tractor, with cable control. Working best in loose or light material, the end portions of the blade extend forward like a U, enabling it to drift large loads for longer distances and bigger job production. The versatility of this new tool gives it excellent performance on all kinds of 'dozing jobs, from stockpiling to pioneering.

CATERPILLAR
REG. U. S. PAT. OFF.

DIESEL ENGINES • TRACTORS • MOTOR GRADERS • EARTHMOVING EQUIPMENT

Could the dependable qualities of this pipe help you reduce the cost of delivered water?

Centrifugally spun, reinforced concrete pressure pipe with double rubber gasket joints combines strength of steel with permanence of concrete.



Circumferential reinforcement is provided by accurately fabricated steel rod cage assembly. Single or double cages may be used to meet requirements of internal pressure, external loading, or combinations of the two.

Centrifugally compacted wall of well-made concrete completely encases and protects all of the steel reinforcement.

Smooth interior surface assures maximum sustained flow characteristics.

Groove in each end of pipe accommodates round rubber gasket which, upon closure, is compressed by joint band to provide positive water tightness.

Steel joint band, installed in the plant on one end of each section of pipe, compresses rubber gasket in spigot groove. Pipe, as delivered to the jobsite, is actually a bell and spigot pipe — ready for quick, easy installation.

Appearance of bell and spigot ends just prior to closure. Inside and outside annular spaces are completely filled with cement mortar.

In recent years, development by this company of the Double Rubber Gasket Joint for centrifugally spun pipe has greatly increased its versatility and adaptability. It is proving outstandingly successful in a wide variety of installations throughout the West. Here are typical examples:

Coachella Valley County Water District, Coachella, Calif. (U.S. Bur. of Reclamation Project), Units 5, 6 and 7—270,000′, 12″ thru 72″; operating heads up to 75′.

Olympia, Wash. (McAllister Springs Water Supply Line) 35,000′, 36″; operating head, 150′ max.

San Diego County Water Authority (San Diego Aqueduct—Sweetwater Extension) 23,500′, 18″– 24″; operating heads up to 130′.

Available in diameters from 12″ through 84″, and for moderate operating heads (generally up to 125′), this pipe is another example of American's ingenuity and skill in the development of better products for water supply lines. Further information is available upon request.

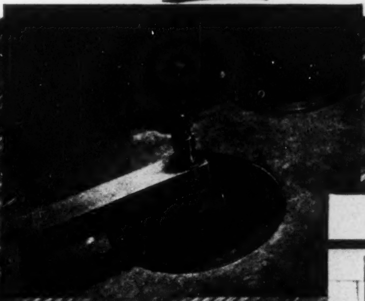
Concrete Pipe for Main Water Supply Lines, Storm and Sanitary Sewers, Subaqueous Pipe Lines.

American PIPE AND CONSTRUCTION CO.

P. O. Box 3428, Terminal Annex • Los Angeles 54, California

QUALITY PIPE LINE PRODUCTS MANUFACTURED AND INSTALLED BY AMERICAN INCLUDE HUME CENTRIFUGAL CONCRETE PRESSURE PIPE, AMERICAN CONCRETE CYLINDER PIPE, PRESTRESSED LOCK JOINT CONCRETE CYLINDER PIPE, LOCK JOINT CONCRETE CYLINDER PIPE.

Main Offices and Plant—4635 Firestone Boulevard, South Gate, California — District Sales Offices and Plants — Oakland — San Diego — Portland, Oregon.



ALL ROPES *look* ALIKE... but

IN *Wickwire Rope*

TESTING GOES

Precision polishing and high powered magnification enable us to go 100 times beyond normal vision in examining Wickwire Rope steel for classification of grain size to McQuaid-Ehn* standards.

100 times beyond normal vision

Uniformity of grain size in steel assures longer life and greater reliability in Wickwire Rope.

Right down the line...starting with the melting and refining of our steel ...and continuing through heat treating processes and cold drawing of the wire, we maintain complete control over the grain size of steel used in Wickwire Rope.

This quality control of basic properties is possible only with a company whose operations are fully integrated from the actual making of the steel to the stranding of the finished rope. It's just one more example of how Wickwire goes "beyond specifications" to give you—at market prices—wire rope that is unsurpassed for reliability, safety and longer life.

See your local Wickwire distributor for the right rope for your particular requirements. Wickwire Rope is available in all sizes and constructions, both regular lay and WISSCOLAY *Pre*formed.

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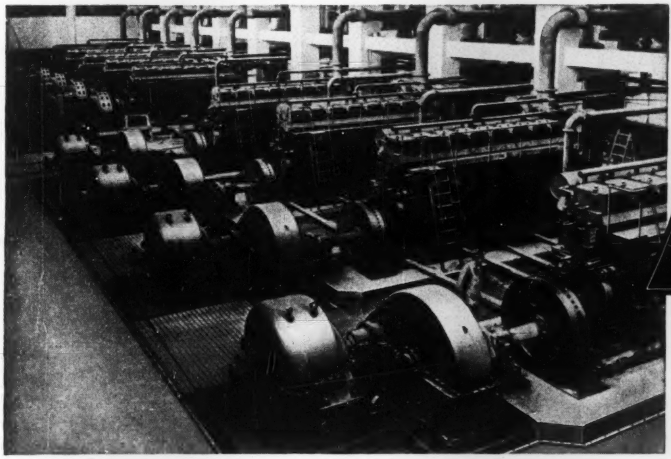

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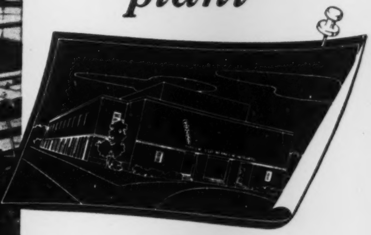

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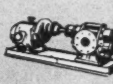

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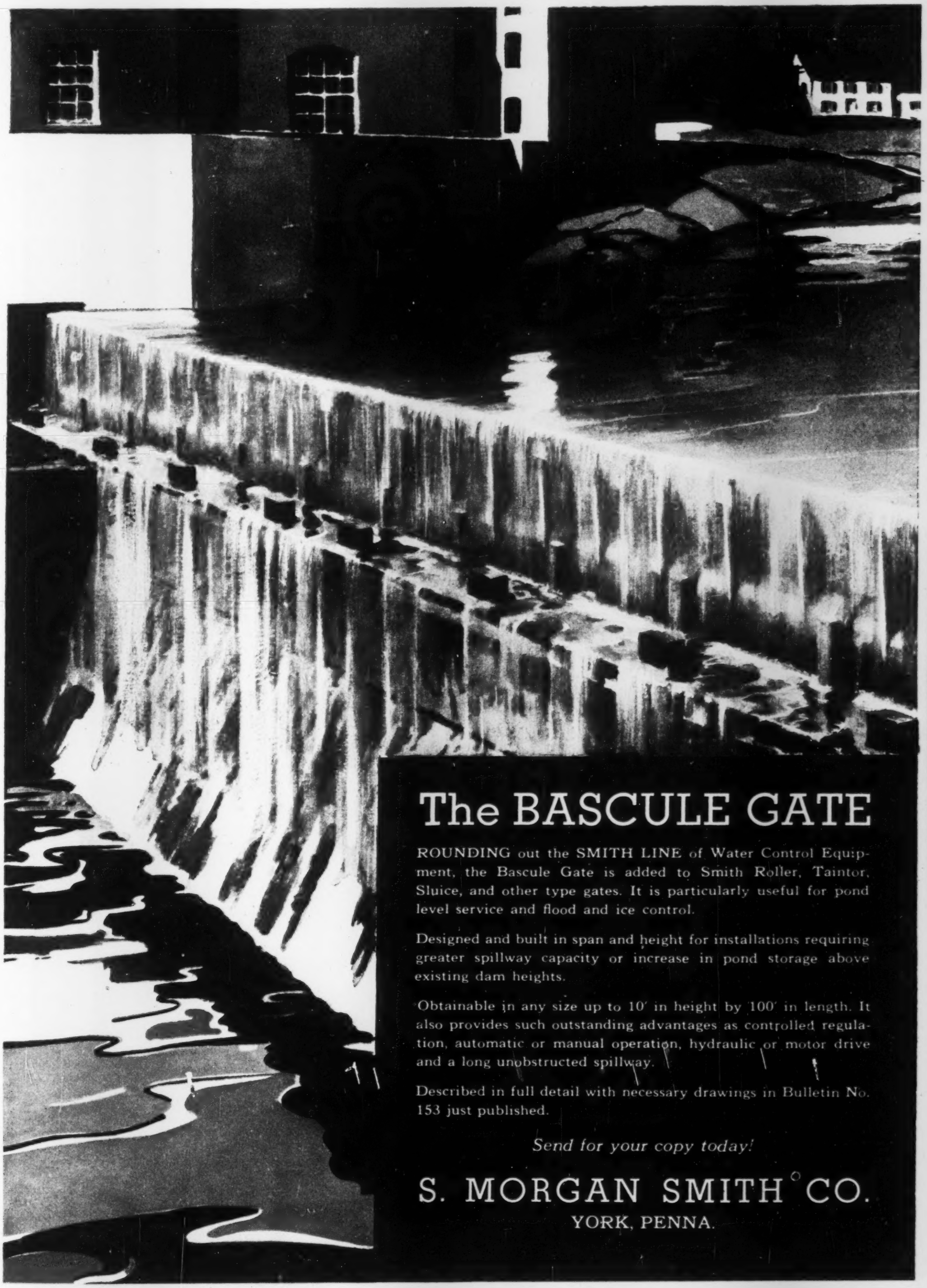

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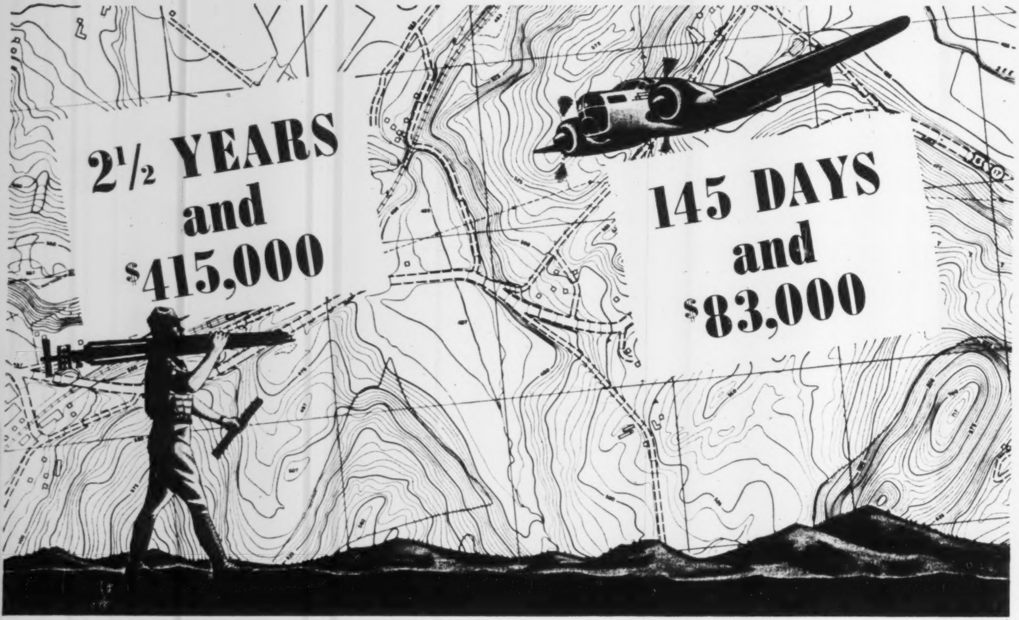

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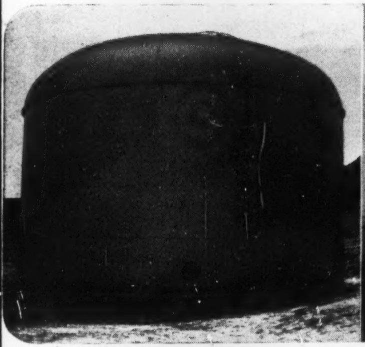

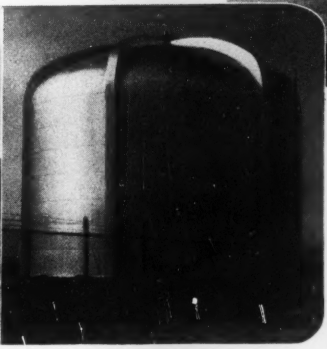

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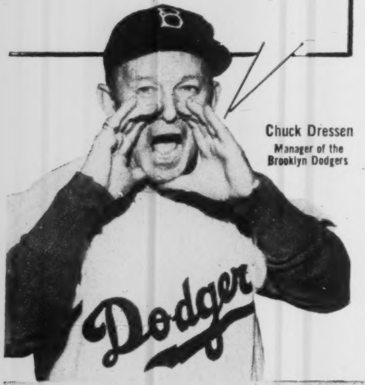

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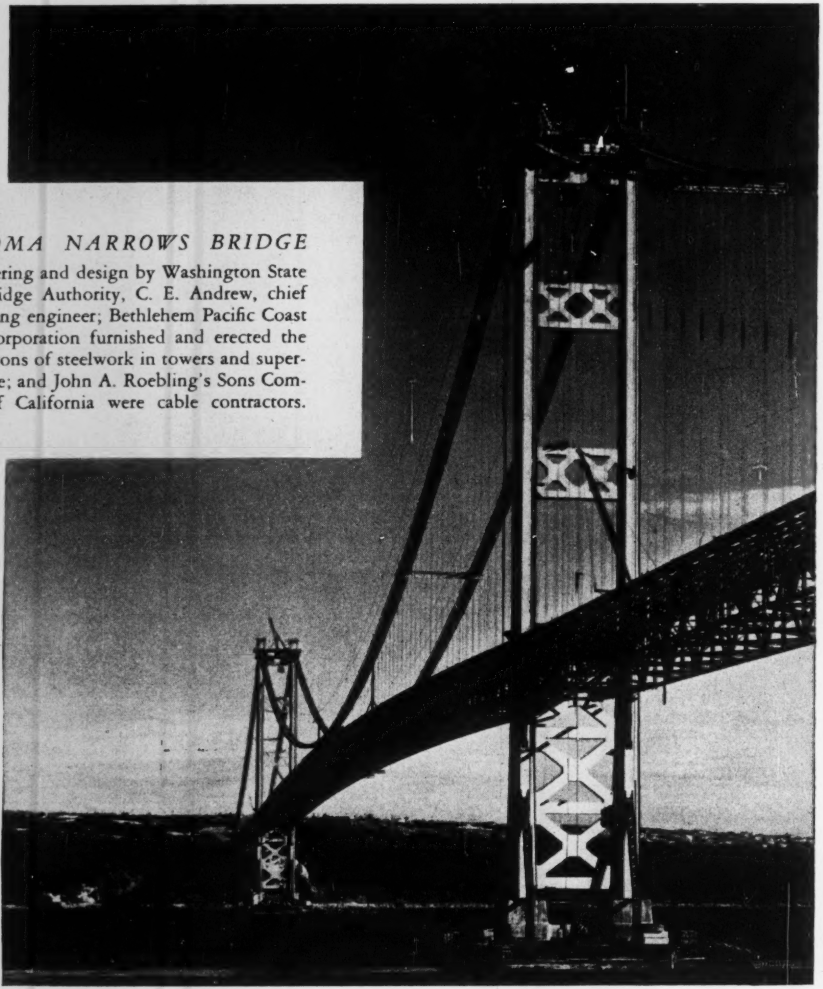

TACOMA NARROWS BRIDGE

Engineering and design by Washington State Toll Bridge Authority, C. E. Andrew, chief consulting engineer; Bethlehem Pacific Coast Steel Corporation furnished and erected the 16,000 tons of steelwork in towers and superstructure; and John A. Roebling's Sons Company of California were cable contractors.

Network of Steel Over Puget Sound

This is the Tacoma Narrows Bridge, spanning Puget Sound and connecting the countryside of the Olympic Peninsula with the Tacoma-Seattle area. The third-longest suspension span in the country, it measures 2800 ft between the towers, and 5978 ft in over-all length. Its main towers rise 502 ft above water-level, and the bridge cables supporting the structure's 4-lane roadway are $20\frac{1}{2}$ in. in diameter.

The Tacoma Narrows Bridge was engineered and designed by the Washington State Toll Bridge Authority. Fabrication and erection of the structure's 16,000 tons of steelwork were handled by Bethlehem Pacific Coast Steel Corporation, Bethlehem's Pacific Coast subsidiary.

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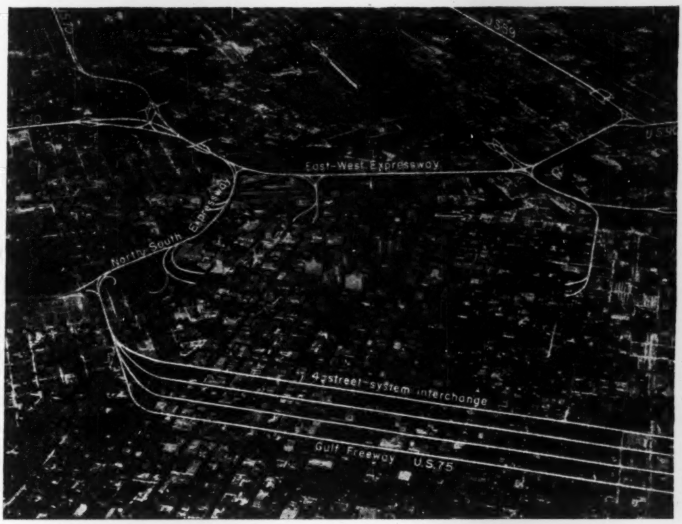


W. J. VAN LONDON

Engineer-Manager,
Houston Urban Expressways,
for Texas Highway Department

Projected expressways to serve congested central business section of Houston are indicated by white lines. More detailed layouts for North-South and East-West routes appear on following pages.

THAT PART of the Houston Urban Expressway now being used, commonly called the Gulf Freeway, should repay its $11,000,000 construction cost in four years. This calculation, based on the recognized minimum cost of operation of 2 cents per minute for passenger cars and 5 cents per minute for trucks, clearly emphasizes the fact that despite the high cost of expressway construction today, few investments pay so high a return—25 percent in this case.

For the benefit of those who may not be familiar with the manner in which urban expressway work is handled in Texas, a brief outline may be of interest. In 1945 the State Highway Engineer established the office of engineer-manager in the four major cities of Houston, Dallas, Fort Worth, and San Antonio. Each engineer-manager became responsible for the location, design, and construction of the expressways in his city. Locations for the expressways are made in cooperation with the cities, which acquire the rights-of-way and pay all right-of-way costs. All design and construction costs are paid for out of state and federal funds, usually on a fifty-fifty basis.

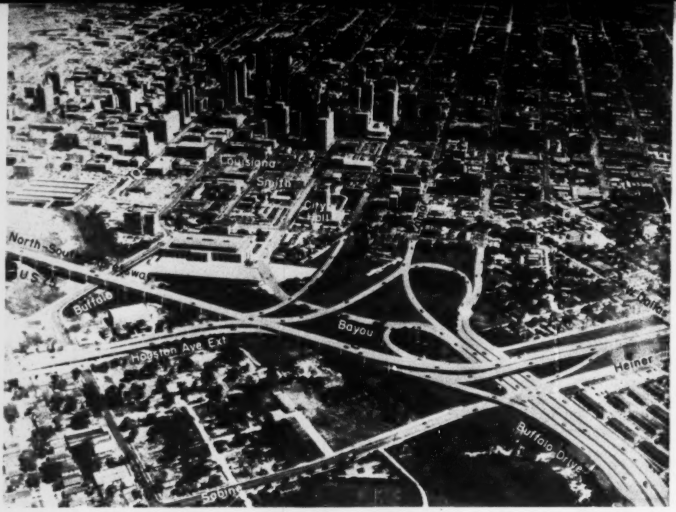
Agreement has been reached between the State Highway Commission and the City of Houston on a north-south and east-west expressway system for that city of about 30 miles. The construction cost would be about 50 million dollars and the right-of-way cost an additional 20 million at current property values and condition of development. Since land values are rising rapidly, right-of-way costs will be prohibitive when funds for construction become available unless something is done promptly to reserve the required right-of-way. Therefore definite steps are being taken to reserve rights-of-way for these and other expressways, even though the routes cannot be constructed for 15 or 20 years.

Rights-of-Way Reserved

The State of Texas has prepared strip maps showing the maximum rights-of-way required for the traffic facilities contemplated. The City of Houston has passed ordinances approving the locations, establishing the outer boundaries of the rights-of-way and directing that no building permits be issued for structures within such boundaries. In the designated areas, the director of Public Works refuses to issue permits for new improvements or alterations costing more than 25 percent of existing improvements, citing the ordinance as his authority.

In cases where the property owner protests, the city acquires the property by negotiation or condemnation. In the past two years the city has been forced to expend about $500,000 on such cases. This probably represents less than 10 percent of the total right-of-way cost. Improved property which is not to be used for some time is leased by the city. The annual rentals amount to about 6 percent of the purchase price.

Under this procedure Houston has reserved about 15 miles of right-of-way for future expressways. While a definite figure cannot be set for the saving that will be realized by this procedure, it certainly will be several million dollars. A far greater saving could be effected if the city had funds to purchase all the rights-of-way now, but like most cities, Houston is unable to finance current needs. However, the procedure reserves a suitable location for expressways, which probably is of greater importance than the monetary saving.



SKETCH OF NORTH-SOUTH EXPRESSWAY is superimposed on aerial view of Houston. Studies indicate that double-deck, elevated structure is logical solution to traffic problem. At present prices, structure would cost about $5,000,000 per mile.

Since urban expressways usually connect with major highways at the outer limits of the urban areas, many people believe that such expressways are designed primarily for traffic passing through cities. This is not the case. A careful survey disclosed that only 6 percent of the traffic using expressways in Houston would be through traffic.

Another misconception is that urban expressways are somewhat of a dream-way for joy riders. The error of this view has been proved by daily traffic counts on the Gulf Freeway, which show that the lowest traffic volumes occur on Sundays, holidays and Saturdays, and the highest on Thursdays and Fridays.

Probably the greatest misconception is that expressways should be used only by passenger cars. Our whole economy is so intimately geared to the automotive vehicle that to prohibit the reasonable use of trucks or buses on any major traffic artery would prove a very serious error. In fact, it is probable that with increased congestion in the central business section, there will be almost as many trucks and buses on some sections of our expressways as there will be passenger cars.

Gulf Freeway Carries 70,200 Vehicles per Day

Construction of the Houston Expressway System was started in 1946 with the section now known as the Gulf Freeway, which will form part of the limited-access highway to extend from Houston to Galveston, a distance of 50 miles. About 6 miles have been completed. The first 3½-mile section was placed in operation October 1, 1948. On the first day this section was in service the traffic count was 28,800 vehicles. Traffic has now reached an average of 65,500 vehicles per day, with a peak load of 70,200 vehicles. Traffic studies made in 1944–1945 indicated that 70,000 vehicles a day would not be carried until 1957. The traffic expert at that time wondered if his data were correct, and the layman knew the prediction was ridiculous. The estimated capacity of this section of expressway, utilizing frontage roads as well as the freeway lanes, is 100,000 vehicles per day. No prediction has been made as to when this load will be reached.

The superficial design of this section of expressway consists of six 12-ft freeway lanes, three in each direction, divided by a 4-ft median strip, 6 in. high, with a 10-ft surfaced emergency parking lane on each side, except over bridges. On each side of the freeway lanes, where required to serve adjacent property, there is a 32-ft frontage road, consisting of two 12-ft traffic lanes and one 8-ft parking lane.

Street and railroad grade separations with traffic interchange connections to cross streets average about one every half mile. All traffic interchanges are of the diamond pattern, permitting traffic to move in a direct diagonal course from and to the freeway without the reverse rotary movement required by the conventional clover-leaf design. The design speed on the freeway lanes is 50 mph. The safe speed is much higher and depends on the driver and on traffic conditions. The posted speed is 45 mph, but the average speed of passenger cars is about 50 mph.

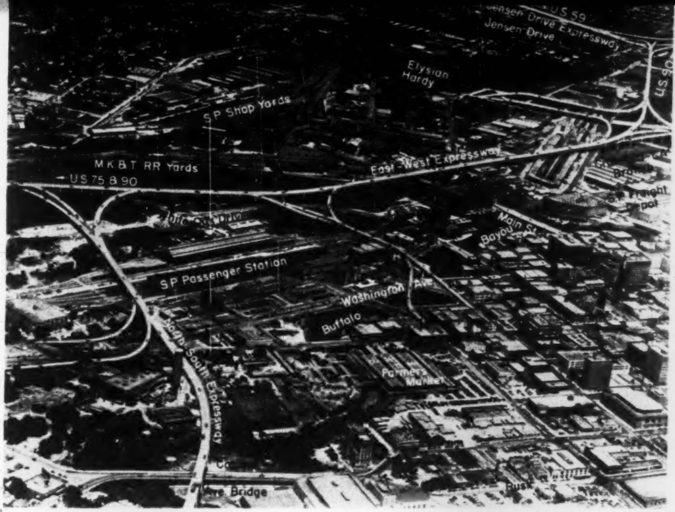
Traffic Collection System

A unique feature of the Gulf Freeway is the traffic collection and distribution system near the central business area. The usual method of loading and unloading a freeway is through a few interchange points, often of the clover-leaf type, to major cross streets. The Gulf Freeway is loaded and unloaded through a four-street system 1¼ miles long, which merges with the Gulf Freeway to the southeast and will later merge with the North Expressway to the northwest. This four-street system intersects 18 north-south streets which carry almost all the huge volume of traffic between the central business area and the southern and southwestern sections of the city.

All traffic movements through the 72 intersections are controlled by an interconnected, synchronously operated, traffic-control, signal system. The four east-west streets and the 18 cross streets thus controlled, constitute a master interchange of great magnitude, capable of collecting and dispersing the very large volumes of traffic demanded of it, rapidly and efficiently. The volume in 1949 was 181,000, and is now estimated at over 200,000. The four-street system was improved and a traffic signal system installed by the state at a cost of $1,100,000.

On the first 3¼ miles of the Gulf Freeway, mercury vapor lamps have been installed to provide an average of 0.8 ft-candles at road level. The cost was about $317,000. For the present, the installation of all illumination has been discontinued because of high installation and maintenance costs.

Design standards for pavements and structures are of the highest order. Briefly, all designs provide for handling the present maximum legal truck loading of 18,000 lb per axle with a safety factor of between 2 and 3. Every effort is made to avoid unnecessary features, and to maintain the greatest simplicity commensurate with functional design and good appearance. A very considerable saving has been effected in bridge foundations by using round shafts cast in drilled holes, called drilled-type foundations. It is estimated that the cost of this method was 50 percent less than it would have been following the usual foundation practices, with the result that a saving of approximately $325,000 has been realized on the 6 miles of completed work.



CHOICE of elevated structure for East-West Expressway is indicated because area is covered with industrial buildings, railroad yards and streets. In 6-mile length there are 62 railroad tracks and 26 streets. Nine stream crossings would interfere with depressed location.

The drilled type of foundation, commonly called under-reamed, is sketched in Fig. 1. This foundation consists essentially of a number of circular reinforced concrete shafts of relatively small diameter to transmit the load to the soil, with the bottom part of each shaft enlarged sufficiently to distribute the load over a large area, all excavation being done with rotary drilling and under-reaming tools. Besides ease of excavation, other economic advantages of this plan are the elimination of forms below the ground line, elimination of all backfill, absence of appreciable remolding or disturbance of soil around and under the foundation pier, and development of good bond and resulting high skin friction between pier and surrounding soil.

Use of this type of foundation requires a rather thorough foundation exploration to determine the feasibility in each case. Exploration is accomplished by means of test holes sufficiently large to allow personnel to actually enter the holes and examine the soil formations in their natural condition. Since the test holes are of about the same size as the actual foundation holes, and are under-reamed at each depth considered as a possible footing depth, the successful completion of a test hole in any given location leaves little doubt as to the practicability of constructing the actual foundation in that location and also supplies interested contractors with reliable field information such as casing lengths required, if any, troublesome water-bearing or caving formations, etc. This information allows contractors to bid on the work with less uncertainty and thus ultimately results in lower unit bid prices.

The average cost of work completed and under contract is $1,600,000 per mile. While this cost is high for construction, it is not high in terms of vehicle-miles of service rendered. On this basis, it is approximately equivalent to a farm-to-market road costing $8,000 per mile and carrying 300 vehicles per day.

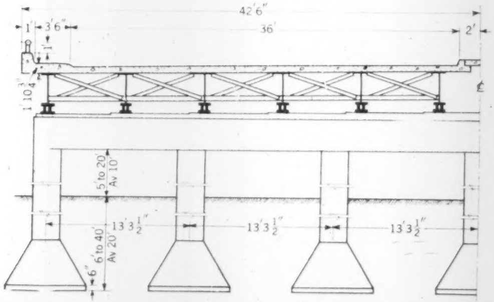


FIG. 1. ROADWAY is supported on round reinforced concrete columns with under-reamed bell-shaped footings. No forms are required below ground.

The type of expressway just discussed, which passes through residential and lightly developed industrial areas of Houston, is relatively simple and inexpensive when compared to the type that would be required in the highly developed area to the west, north and east of the central business section. Most of the area through which it is necessary to locate the projected East-West Expressway, in order to reach the origin and destination of the traffic, is covered with industrial buildings, railroad yards and streets.

In the length of 6 miles of expressway and exit-entrance ramps being considered, there are 62 railroad tracks and 26 streets that must be left open to traffic. There is no four-street system available to collect and distribute traffic. At several points the traffic must be carried at right angles to the expressway for a considerable distance to reach suitable street connections in industrial areas and near the central business section. The average distance between major street and railroad crossings is about 700 ft, and in many cases less than 400 ft. Therefore, if a freeway is developed here, the entire facility must be at least partially depressed or partially elevated. With nine stream crossings in the area, a depressed freeway is out of the question.

Double-Deck Structures Indicated

Studies of an elevated expressway indicate that a double-deck structure providing for one-way traffic on each level might be the solution to the problem. In some cases such a structure would follow existing thoroughfares with supporting columns astride the streets, which would remain in service. Double- and single-level structures would be required to carry traffic to street connections in the central business and industrial areas. In such an area the financing of any type of expressway is a far greater problem than the designing.

The expressway section would cost $5,000,000 per mile at present prices. Entrance and exit ramps would cost about $3,500,000 per mile, making a total of about 30 million dollars for a 6-mile length, a staggering amount. Where the money will come from, and when, no one knows. However, the monetary savings to the user would be greater in this area than on the Gulf Freeway. It is estimated that such savings would equal the cost of the facility in less than 10 years.

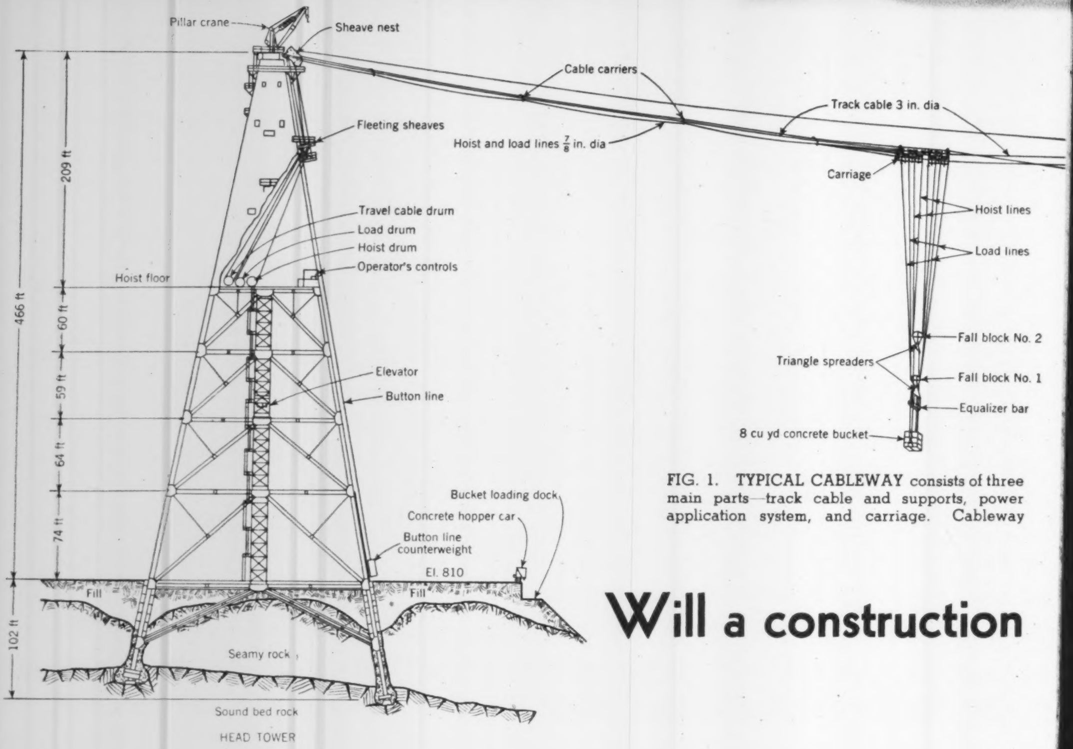

Pillar crane
Sheave nest
Cable carriers
Track cable 3 in. dia
Fleeting sheaves
Hoist and load lines $\frac{7}{8}$ in. dia
Carriage
Hoist lines
Load lines
Travel cable drum
Load drum
Hoist drum
Operator's controls
Hoist floor
209 ft
466 ft
60 ft
59 ft
64 ft
74 ft
102 ft
Elevator
Button line
Fall block No. 2
Triangle spreaders
Fall block No. 1
Equalizer bar
8 cu yd concrete bucket
Bucket loading dock
Concrete hopper car
Button line counterweight
El. 810
Fill
Fill
Seamy rock
Sound bed rock
HEAD TOWER

FIG. 1. TYPICAL CABLEWAY consists of three main parts—track cable and supports, power application system, and carriage. Cableway

Will a construction

WHETHER OR NOT to select a cableway for a particular construction job is a matter of judgment. And such judgment must be based on an appraisal of the physical characteristics of the job, the wage structure, union usages, and availability of skilled labor. In countries where the living standard is low, it is necessary to consider the practicability of importing or developing the trained men required to erect and operate a cableway. Thus a cableway is not the solution for all problems.

Of course many construction projects do lend themselves to the use of cableways—such as long cuts and adjacent fills, graving docks, deep quarries and similar excavations, sewage disposal plants, dams, bridges, penstocks, isolated high structures, and heavy loads which must be moved over difficult terrain for short distances. Choice of cableways in the United States is generally based on a consideration of the span required, first cost, salvage value and operation cost.

For example, the Easterly Sewage Disposal plant in Cleveland, Ohio—a low, scattered structure resting on piles, was built economically by cableways with towers traveling on parallel tracks. If this structure had been located on open and good ground it probably could have been built more cheaply by crawler crane.

A relatively long, low dam often can be constructed by trestle, whirley crane, or even crawler crane, more economically than by cableway, depending on the nature of the terrain and the stream to be diverted. Closure of the deep gap at McNary Dam on the Columbia River, for instance, could be accomplished only by cableway. There necessity, reinforced by judgment, dictated the selection of the cableway method. No hard and fast rule can be set because much must be left to judgment and experience—even in some cases to professional prejudice or preference.

A heavy-duty span of over 2,700 ft usually is uneconomical for a cableway. Because of its relatively high first cost, a cableway must be a heavy-duty tool, capable of handling loads up to 50 tons at speeds required by the construction schedule. If the project is one that cannot reasonably absorb the cableway's cost less its salvage value, other tools should be selected—unless of course physical obstacles are such that only a cableway will do the job.

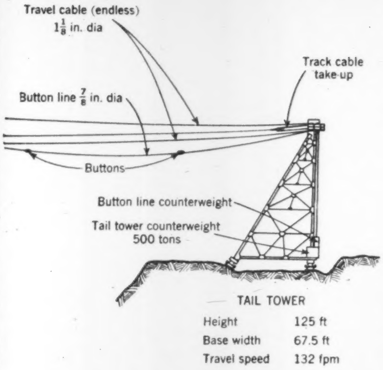
All cableways require expert erectors, operators and maintenance crews. If skilled men are not available, it will be impossible to build or operate a cableway at a reasonable cost, and the contractor will be severely penalized. Therefore a cableway should only be selected when a staff trained in this type of work is available.

The building of relatively high dams in narrow canyons nearly always requires cableways. This has been true especially since modern concrete specifications have practically eliminated the use of chutes. Usually the assembly of embedded metal parts, penstocks and gates, and their erection in a dam, require cableway service, as does also the removal of spoil from difficult excavation. These factors add up to a "must" for the cableway in the construction of this type of dam.

Cableway Has Three Main Parts

A cableway consists of three parts (Fig. 1): (1) the track cable (on which the carriage runs) and its supports, (2) the power-application system, and (3) the carriage. The track cable may be attached to stationary anchors, moving towers, stationary masts, or a combination of these.

The power-application system has two functions, and sometimes three: (1) to move the carriage on the track cable; (2) to lift and lower the load; and (3) to move towers when re-



sketched is one of seven which radiated from single head-tower at Shasta Dam and placed $6^1/_2$ million cu yd of concrete in structure. Three had spans of 2,670 ft; one, 2,115 ft; one, 1,798 ft; one, 979 ft; and one, 720 ft. All were equipped with American standard tandem carriages.

© *McCulloch Brothers*

SIMPLE English-type carriage (left) of 5-ton capacity was used on 1,900-ft-span cableway for construction of Lake Pleasant Dam in Arizona (1926). Head-tower consists of stationary guyed mast.

DRY DOCK for Terminal Island Navy Base, Calif. (below), was built in 1941 by means of two parallel-track cableways of 1,100-ft span. Note thrust tracks for traveling towers at each end of cableways.

© *U.S. Navy official*

cableway fit your job?

J. G. TRIPP, M. ASCE, Consulting Engineer, New York, N. Y.

quired. The power source may be a self-contained gas engine located in the carriage itself, in which case the operator rides in the carriage, or it may be located at the track-cable anchors, towers, or masts. In the latter case, the power is exerted through two hoists, one of which pulls the carriage back and forth while the other winds the load cable, sheaved through the carriage to raise and lower the load. A third type of carriage lifts the load by means of a rope-drive engine installed in the carriage and actuated by an endless power-rope transmission cable driven by a hoist at one of the anchors. The rope-drive engine drives the hoist to which the lifting lines are attached. The third function, moving the towers, will be discussed later.

The simplest cableway carriage is the English type (Fig. 2*a*, page 27), which is highly useful on a light-load, slow-speed cableway. Its first cost is normally moderate, and repair and operation costs depend on the span and the skill of the operator. The English cableway carriage consists of a simple frame enclosing track wheels at the top and two cable sheaves at each end of the lower part. The travel cable is attached to each end of the frame and runs endlessly through sheaves positioned at each end of the track cable. The hoist that operates the endless travel cable may consist of either one or two spools or one or two grooved drums. Or a set of pay-on-pay-off winding drums can be substituted.

The load cable runs off a single-drum hoist at one end of the track cable, passes over the nearest carriage-sheave, down and under the load-block sheave, and up over the second carriage-sheave to a dead-anchor at the far end of the track cable. This simple arrangement requires the least travel power but is very hard on the load cable, as it is flexed no less than three times as the carriage moves ahead and again as it moves back.

When the anchor end of the load cable is dead-ended on the far sheave of the carriage, as is done in the modified English type (Fig. 2*b*), there are only two flexes of the cable. In this case the travel cable has to resist the pull on the load cable as well as its own tension. Either load-cable hook-up has to allow for considerable sag in the load cable. When the sag in the operating lines causes interference between cables and structures below, so that cable carriers or spacers are necessary, the usefulness of the English-type carriage ends.

This use of carriers to eliminate undue sag in the cables for the American standard carriage (Fig. 2*c*) is the essential difference between this carriage and the modified English type, which employs no carriers. The travel cable for the American standard carriage—as well as that for the modified English type—must resist the pull of the load cable in addition to the travel load. The power requirements for these two types are therefore larger than for the simple English type.

The cable-carrier system which controls the sag in the operating lines has been the source of considerable operation cost and general grief to operators. One factor is the weight of the carrier units, which add to the load on the track cable and to that on the carriage. Also a button line or a substitute arrangement must be installed to space the carriers, and provision must be made for the button-line reactions on the track-cable anchors or towers. The system is noisy and full of shocks but it works—and has for many years. As the carriage travels out and back on the track cable, the carrier frames are alternately removed from the horn on one end of the carriage and picked up by it. The operating lines run over sheaves inserted in the carrier units. As the carriage moves out-

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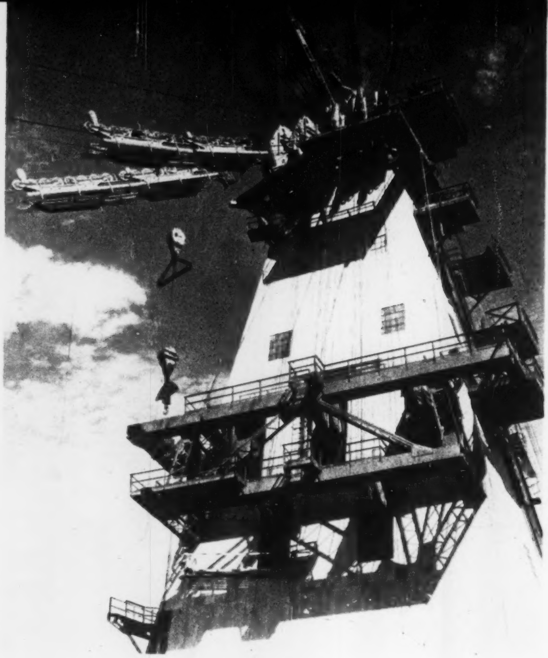
HOISTS AND CARRIAGES (above) for three cableways of 25-ton capacity, used on Hungry Horse Dam, Montana (1950), were previously employed at Shasta, Parker, and Hoover Dams. One hoisting line dumps concrete bucket in this installation.



HEAD TOWER (right) for Shasta Dam's seven radiating cableways had to take a heavy one-sided pull. There was no precedent to guide the design of this 466-ft-high structure, anchored 100 ft deep into bedrock, which contained 4,092 tons of structural steel. Hoists and carriages were built by Lidgerwood Manufacturing Co., and track cables were made by American Steel & Wire Co.

ward the buttons on the track cable pull the carriers off, and as the carriage returns the horn picks up the carrier units as the carriage runs into them. The many operating tricks used to decrease wear on the button line, and thus increase its life, fill the handbook of trade secrets of cableway operators.

Most cableway carriages run on a single track cable. However, there are uses for carriages which operate on two or more track cables. In such cases the carriage should contain its own power unit, since the powering of a multiple track-cable unit by remote hoists is complicated and often impracticable. The single exception is the permanent 150-ton cableway at Hoover Dam, but this is a special tool and would hardly be used for construction purposes.

Track cables vary from 3/4-in. plow steel to 3 1/4-in. lock coil cable. Each size and specification has it uses. Operating lines vary between 1/2 and 1 1/4-in., and carriage weights from 1/2 to 15 tons. Design loads may vary from 1 ton to 50 tons, and hoists from 20 to 700 hp.

Carriage designs range from the simple English with its two track wheels and two-sheave load-tackle frame, up through four-wheel, eight-wheel and twelve-wheel single frames, to tandem frames of eight wheels or more each (Fig. 3). The number and arrangement of the load-tackle sheaves depend on the user's requirements. For instance, at dams such as Hoover, Shasta, and Hungry Horse, two four-part tackles were used, while at Mount Morris Dam a single four-part tackle is now being employed. The type of tackle is determined by the method of dumping the concrete bucket, whether it is hoist controlled by the operator, or power controlled at the working spot. The operator method of dump control was used for placing the concrete tetrahedron and muck for the river closure at McNary Dam.

Among the recent advances that have been made in the design of cableways, the principal one is the advent of the "Travelift" carriage (Fig. 4). This invention is said to successfully eliminate button lines and cable carriers on installations of less than 25-ton capacity. On this carriage is mounted a cable-powered engine operating a chain-driven load-hoist. This type of rig has overcome the deficiencies in English and American standard cableways long known to operators. The Travelift principle dispenses with the horn-rig button-line entirely, because the sag in travel and power-transmission cables is adjusted to the scope or sweep of the track cable. In the power cable the sag is maintained by a counterbalance loop in the tail towers, and by proper tension in the travel cable.

Because of the wear and tear and shock on the button line and carriers, the speed of the American standard carriage should not exceed 1,500 fpm. Higher speeds lead to accidents and to broken button lines, which fall on men and structures. Without the carrier system, it is said that carriage speed can exceed 2,200 fpm, as it is limited only by the characteristics of the track cable and its ability to handle speeding wheels.

A parting overhead cable is a source of grave danger, which can only be controlled by constant inspection and replacement of cables as is done in the elevator industry. In the Travelift carriage, however, the power is applied to a cable-driven engine on the carriage, and therefore on this type of installation the parting of the drive cable will not affect the load since the gear train to the hoist is braked. Should the travel cable part, the drive cable would hold the carriage and no sweep and fall of the load would occur as it would with the modified English or standard American rig.

Another advantage of the cable-drive carriage is that a two-part hoisting line will handle the same load as the four-part used in the American standard, because of the carriage-hoist control. The addition of a second drum would give the user a tackle to dump the bucket. This rig can be used as a clam-digger outfit. When the second drum is added, however, a second drive cable and hoist is required. The Travelift type allows travel and raising or lowering at the same time with control and safety. In either the English or the American standard, the combination of travel, lowering and raising can only be done with difficulty and danger.

Transmission of power to a hoist on the carriage by wire rope is an old idea. Twenty-two years ago the idea was used on a cableway at Coolidge Dam but it was very slow and unsatisfactory. The Travelift arrangement is fast and will probably become a satisfactory tool.

To lay out and design a cableway, an accurate contour map is the first requirement. Rail systems for traveling towers must be located for economical excavation quantities. It is a common practice to set the cableway spans and towers to the contours and not to the structure to be served.

Frequently a cableway system cannot cover the whole structure economically; some sections must be served by other means. However on many jobs no auxiliary means is required. At Shasta, the long, high dam was served by a central headtower and seven concentric traveling tail-towers. The central tower was 460 ft high and required 4,092 tons of steel. The seven radial cableways were located to place 6,500,000 yd of concrete together with several thousand tons of steel and pipe. At Mt. Morris Dam, near Rochester, N.Y., two radial cableways of 1,700-ft span attached to a stationary headtower, are placing 750,000 cu yd of concrete and a large tonnage of pipe. Other dams, like Hoover, employed

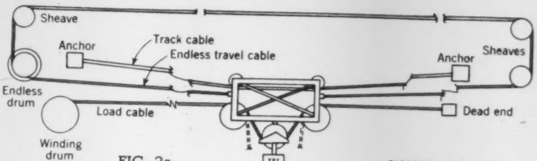

Sheave
Anchor
Track cable
Endless travel cable
Anchor
Sheaves
Endless drum
Load cable
Dead end
Winding drum
W

FIG. 2*a* SIMPLE ENGLISH

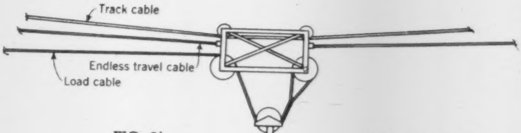

Track cable
Endless travel cable
Load cable
W

FIG. 2*b* MODIFIED ENGLISH

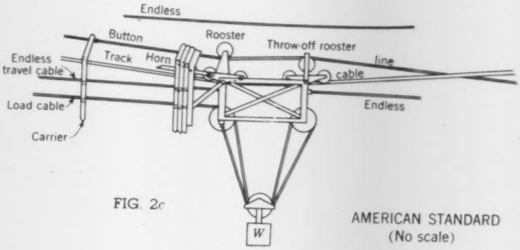

Endless
Button
Rooster
Throw-off rooster
line
Endless travel cable
Track
Horn
cable
Load cable
Endless
Carrier
W

FIG. 2*c* AMERICAN STANDARD (No scale)

FIG. 2. THREE STEPS in development of simple cableway carriage are: (*a*) simple English, (*b*) modified English, and (*c*) American standard with button line for cable carriers.

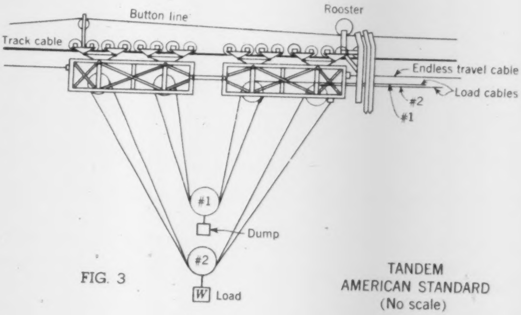

Button line
Rooster
Track cable
Endless travel cable
Load cables
#2
#1
#1
Dump
#2
W
Load

FIG. 3 TANDEM AMERICAN STANDARD (No scale)

FIG. 3. FURTHER DEVELOPMENT of American standard carriage is tandem type in which number of load-carrying wheels on track cable is increased and load sheaves are spread further apart to prevent twisting of load cable.

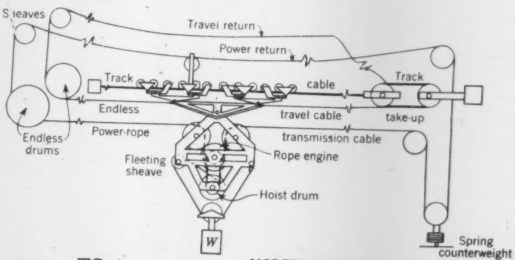
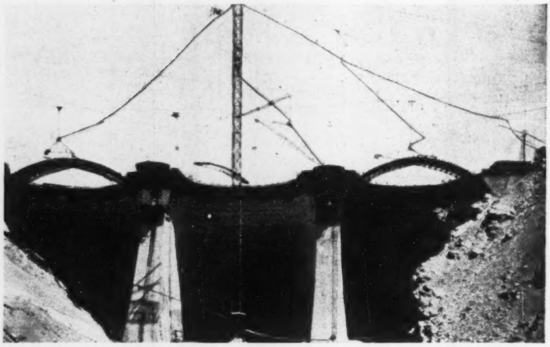

Sheaves
Travel return
Power return
Track
cable
Track
Endless
travel cable
take-up
Endless drums
Power-rope
transmission cable
Fleeting sheave
Rope engine
Hoist drum
W
Spring counterweight

FIG. 4 MODERN ROPE ENGINE (No scale)

FIG. 4. MODERN ROPE-ENGINE CARRIAGE has various advantages. For example, button line and carriers are eliminated; traveling and lifting can be done simultaneously with control and safety; and parting of any one cable does not result in sweep of carriage and fall of load.

FOR CONSTRUCTION of Coolidge Dam in Arizona (1927–1928), two cableways were used. Ten-ton, 1,200-ft-span "high line" (at left) had carriage mounting cable rope-drive engine geared to lifting hoist, seen transporting 5-ton truck. Second cableway, of 20-ton capacity, was equipped with American standard carriage. Concrete was chuted into place from top of tower (below), while cableways handled forms, chutes, concreting tower, penstocks, and powerhouse machinery.



head- and tail-towers traveling on parallel rails. Disposal plants and graving docks usually employ this parallel rail arrangement.

It is good practice whenever possible to set the track-cable connection at the head-tower higher than that at the tail-tower, and to place the head-tower on the delivery side of the work. The saving in power and time realized by moving the greatest tonnage down grade on the track cable, becomes very substantial on a large job.

The design of either stationary or traveling towers can become very complicated. Good engineering requires a least-work analysis and a fine sense of when to exceed good practice. Much money can be wasted in overdesign and frequently is. The traveling-tower thrusts are usually resisted by thrust tracks properly designed, ballasted and drained. Radial tracks present more difficulty than straight track layouts.

The design of the traveling-tower tracks must contemplate stresses due to loss of rail surface, creeping movements of wheel flanges on rail heads, the constant liability to overloading due to flexibility in the towers, and the dynamic effects of the power system on the structure.

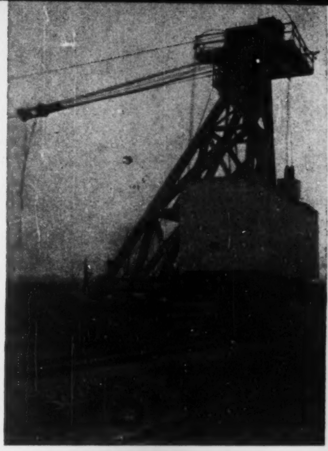
As a guide to the designer, the following list of stresses imposed on moving towers by cableways is given: (1) erection stresses; (2) amount and direction of track-cable reactions under erection conditions, such as tensioning the bight of the track cable to the calculated elevation and stresses induced by critical loads of carriage, ropes and pay load; (3) counterweights; (4) reactions of running lines; (5) reactions of lighting messengers; (6) twisting due to acceleration and movement in traveling; (7) weights of hoists at rest; (8) weights of hoists in operation, with reversal of stresses on occasion; (9) weights of sheaves and their dynamic reaction; (10) weights of auxiliary equipment and operating reactions; (11) weights of enclosures and wind loads on them; (12) addition to all static weights of a general percentage to cover impact—based on judgment and the type of carriage adopted; and (13) the "unlucky" occasional overload. Central towers and masts may be simple or complicated. The location of guys and the several directions of pull from track cables often produce unbelievable results which require the designer to back up and start over again. When in doubt, "make her hell for stout," the advice of the late great Frank T. Crowe, Hon. M. ASCE.

Knowing the traffic schedules to be imposed, the timing and speeds of the traveling-tower propelling gear can be designed. The cost of the designed equipment will be controlled by the length of time the gear is to work. Either jack shafts and chains, or gear-head motors, or hoists and cables will be indicated. In the case of towers traveling on rails, an addition to the counterweight may be required to insure proper traction on the rails at all times and under all conditions.

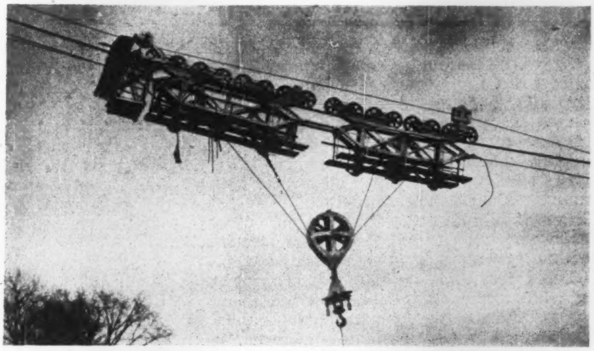
All cableway operations require remote control between the hoist operator and the moving towers. The lines and panels delivering messages to the remote power units must be substantially built and protected, and must be located some distance from the work area. The operator must be in telephonic connection with his signalman at the work spot. The operator's roost should have a clear view of the total job, and if it houses two or more operators it should be divided into noiseproof cubicles so that the operators are shielded from noises originating in the roost or outside. All gear, cables

TWO TRACK CABLES support carriage in which is mounted engine providing motive power for both carriage travel and load lifting. Operator rides the carriage.

© *Engineering News-Record*



TWIN CABLEWAYS of 1,700-ft span are being used to build Mt. Morris Dam, New York (1951). Cableways are equipped with four-part hoisting lines anchored on American standard compound carriage. Note cable carriers stacked on horn attached to left end of carriage. Inclined track (in view at upper right) takes thrust of counterweighted, moving tail-towers.



and hoists must be attended by an oil-rigger on constant inspection duty.

To determine the number of rigs required, assume that the average production of a standard 25-ton cableway traveling a distance of 500 ft at 1,250 fpm and hoisting at 350 fpm, is 1.3 cu yd of concrete per min. Such a cableway will readily handle the capacity of two 4-cu yd mixers. A 400,000-cu yd job can be handled by one such cableway provided it covers the required area, by servicing the job during one shift and pouring during two. This formula can be applied to each increment of 400,000 cu yd, that is, two rigs will handle an 800,000-cu yd job and so on until it becomes economical to add service rigs so that concreting can proceed during all three shifts. The average production will be about 65 percent of the theoretical given above. On very large jobs, therefore, the over-all time allowed for completion controls the number of cableways required.

Where time is not available for the main cableway system to service the job area, an auxiliary or service cableway may be added to move forms, men, muck, steel, and machinery. Service rigs can be slower and less complicated and can be stationary. On many projects service rigs can be installed for special work, and then dismantled and set up again as required to serve other areas of the structure. For example, a rig set up to install gates, trash racks and form work on the upstream face of a dam, can be reset to serve a powerhouse downstream. Here a homemade English carriage may suffice provided proper hoist equipment is available. All stationary cableways must be anchored to properly designed deadmen, preferably of concrete set in deep crosscuts or T-tunnels.

All track cables should be provided with properly designed take-up tackle, which in addition to its function during erection of the track cable, will maintain correct sag during operation. Stretch and changes in length due to temperature can thus be compensated for. When it is necessary to pick up uncontemplated heavy loads, the tension on the track cable can be decreased by increasing the sag. Usually two 25-ton cableways are capable of lifting a 150-ton load if the towers can be depended on.

Most cableways in use today are second hand, many times over. Parts of the original rigs used for dams constructed over forty years ago are still in use—patched up to be sure, but still serviceable. Parts of the Hoover Dam cableways were used at Parker Dam, then at Shasta, and are now in use at Phillpot, Mount Morris, and Hungry Horse Dams. Cableway makers have been and are making machinery which has substantial salvage value.

When the use of second-hand equipment is contemplated, the engineer must depend on inspection by cableway erectors. The man who will be in charge of cableway operation on the job is the one who should pass on the second-hand equipment and have charge of its reconditioning and erection. Be sure you get that man before you start! Watch out for worn parts that may be no longer manufactured and expensive to reproduce. New cableways require attention too. There are usually kinks to be ironed out.

The many cable manufacturers of today can be relied on to furnish the proper ropes and track cable. It is essential to get the actual elastic modulus of the track cable so that the actual stretch-set and elastic elongation can be computed and the proper length ordered. The hoist builder and the carriage maker combine their talents to turn out properly engineered and guaranteed equipment. As with other lines of equipment, the modern manufacturer is the engineer's first line of defense.

WOLFE CREEK DAM, Kentucky, is being built by two cableways anchored to a single head tower. Operating machinery is in moving tail-towers which travel on same radial track. Tracks from mixing plant are located on far bank crossing under cableway.

New ideas mark design and construction of Baytown tunnel

VENTILATION BUILDING of Baytown Tunnel is placed directly over, and integral with, north portal section. Reinforced concrete substructure rests on pile-supported mat. Maximum fresh air requirement of 600,000 cfm can be supplied by two of three fans housed in building.

DESIGN—J. O. BICKEL, M. ASCE,

Principal Associate, Parsons, Brinckerhoff, Hall & Macdonald, New York, N.Y.

DESIGN OF THE BAYTOWN TUNNEL, a trench and precast structure, embraces several new concepts. Probably foremost among these is the elimination of a tremie concrete jacket for the tube which resulted in a considerable saving in construction cost. (CIVIL ENGINEERING, January 1950, page 26). Another innovation was a modification of the Schorer theory of pipeline design, which simplified the construction of the launching cradles.

The tunnel, which connects the cities of Baytown and La Porte, Tex., provides the large oil refinery area north of the channel with a short route to Texas City and Galveston. The long trip around the channel, or the uncertainties of the previous ferry crossing, will thus be eliminated. Portal-to-portal length of the tunnel is 3,000 ft, not including a 550-ft length of open approach at each end. The roadway is 22 ft wide with a minimum clearance of 14 ft at the curve. The structure itself is composed of nine prefabricated sections or tubes.

Pipeline Theory Modified

The stresses in the completed steel shells, as they rest on the launching supports, were calculated in accordance with the theory developed by H. Schorer, M. ASCE ("The Design of Large Pipe Lines," TRANSACTIONS, ASCE, Vol. 98, 1933). Ring and longitudinal bending stresses in the shell plates are very low. Schorer's theory, however, assumes external supports at the ring girders at the level of the horizontal axis of the pipe, which gives the most economical size of ring girders but involves complicated construction of the launching cradles. A modification of this theory developed by H. A. Foster, M. ASCE (CIVIL ENGINEERING, September 1949, page 55) was therefore applied to the design of the ring girders, which are supported at points 30 deg below the horizontal axis. Unit stresses of 22,500 psi for this temporary loading were considered satisfactory.

During the placing of the concrete lining, with the tubes afloat, longitudinal bending and ring stresses change continuously. Excessive transverse moments were prevented by limiting the increase in draft due to the weight of individual pours to about 4 ft. Lontigudinal bending stresses are kept under control by starting the pouring at the quarter points and proceeding uniformly in both directions. A maximum calculated stress of 26,000 psi in the stiffening rings is reached during the second pour, assuming the rings to be cut at the top. These ring stresses are reduced rapidly, as the lining begins to participate and stiffen the shell until a nearly moment-free structure is obtained when the tube is awash. Formulas developed by James M. Paris ("Stress Coefficients for Large Hori-

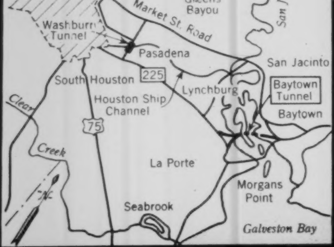
CONSTRUCTION—M. P. ANDERSON, Assoc. M. ASCE,

Chief Engineer, Brown & Root, Inc., Houston, Tex.

THE CONTRACTOR'S lot is not always a happy one, to paraphrase Gilbert and Sullivan. In the case of the Baytown Tunnel, some of the problems encountered are ordinary and can be solved by conventional methods, but others, to keep the job from being dull have involved the working out of special procedures and equipment. Sinking the tubes for the precast tunnel, now going on, falls into the latter category, since the unit weight of the water varies at different points and at different times —from 62.5 lb per cu ft for fresh water, to 69 lb per cu ft for the channel sludge found near the bottom at the tunnel site. Only a 1-lb difference in unit weight of the water changes the uplift on a tunnel section by 140 tons. Dredging of the trench, on the other hand, might be considered in the ordinary category, except that the spoil was utilized as hydraulic fill for the approach roadways.

Trench excavation for the tunnel was performed by the Standard Dredging Co. of Galveston, which used one 30-in. and one 24-in. suction

FIG. 1. Considerable saving in travel distance is realized by carrying traffic across Houston Ship Channel at Baytown. Prior to opening of Pasadena Tunnel north of Baytown, only way to cross channel was by ferry.



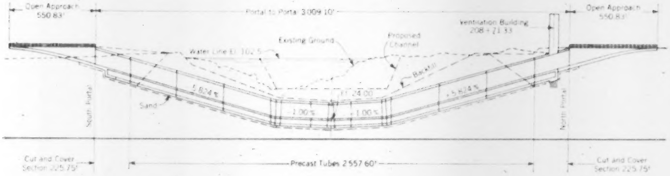


FIG. 2. Main section of Baytown Tunnel is being built by trench and precast method. Cut-and-cover method is used for 225.75-ft section at each end.

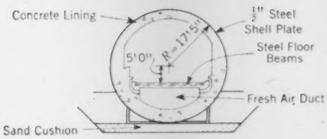


FIG. 3. Concrete for circular cross section of Baytown Tunnel is cast entirely within 1/2-in. steel tube.

zontal Pipes," *Engineering News-Record*, November 10, 1921) were used in the calculations for the various loading stages.

The fresh backfill will have low internal friction resulting in a maximum lateral pressure coefficient, assumed to be 0.50. Since this lateral pressure reduces the moments caused by the direct vertical load in the tunnel, the condition is not critical.

As the fill consolidates, a critical loading is approached since the reduction in lateral earth pressure causes an increase in the moment of the cross section due to the weight of the fill resting directly on the tube. A minimum coefficient of 0.27 for active earth pressure, corresponding to a friction angle of 35 deg, has been selected for this condition, on the basis of a maximum depth of 30 ft of backfill above the last two precast sections at each end.

After the backfill has completely consolidated, it can be considered an elastic continuum. External loads from future filling to a higher level can then be analyzed according to the formulas of Boussinesq or Froehlich, and will give stresses below the design stresses.

The following unit weights have been assumed:

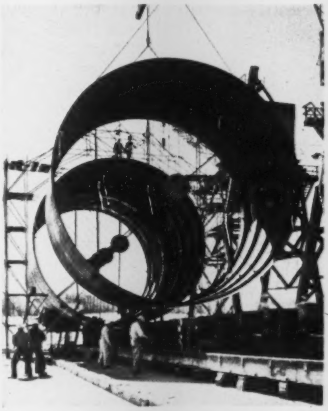
Moist earth above water	110 psf
Submerged earth	62 psf
Water	63 psf

All steel is of regular structural grade. Concrete with a 28-day compressive strength of 3,000 psi has been specified for the interior concrete lining, the roadway slabs of the precast tunnel, the shells of the cut-and-cover tunnel, the heavily reinforced part of the building, and the retaining walls. Specifications for the tremie concrete for sealing the joints between the precast tubes require a 28-day compressive strength of 3,800 psi, but 2,200-psi concrete is specified for all other uses.

In concluding, it may be pointed out that checks made on the alignment of the completed concrete lining of the precast tubes showed deviations of about plus or minus 1/4 in., indicating the accuracy of the design assumptions and the close tolerances maintained in the fabrication of the steel shells and the placing of the lining.

Construction of the tunnel is under the jurisdiction of the Texas State Highway Department, of which D. C. Greer, M. ASCE, is State Highway Engineer, R. B. Alexander Assoc. M. ASCE, Bridge Engineer, and Jim Douglas, M. ASCE, District Engineer in Houston. Parsons, Brinckerhoff, Hall & Macdonald are the consulting engineers for the design of the tunnel and the supervision of its construction; and Brown & Root, Inc., of Houston, are the contractors for the precast tunnel. The steel shells were built by the Consolidated Western Steel Corp. at Orange, Tex.

(This article is an abstract of Mr. Bickel's paper presented before the joint session of the Construction and Structural Divisions, at the ASCE Houston Convention.)



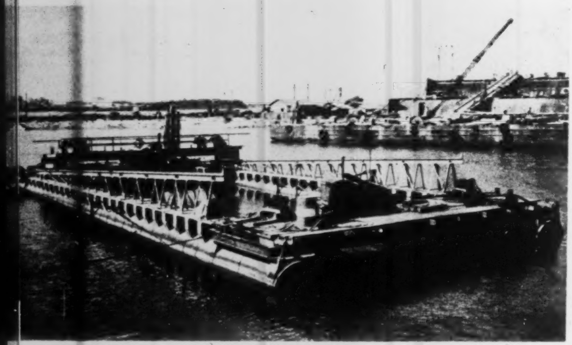
CIRCULAR COMPONENT of tunnel section is lowered into position on ship's ways. This subassembly, commonly called a "can," is hand welded to tube assembly. Can itself is machine welded.

dredge. About $1\frac{3}{4}$ million cu yd of material from the trench and borrow areas were used in the approach fills. Excavation was paid for as embankment at a unit price per cubic yard within specified slope limits. Considerable difficulty was encountered on this hydraulic fill work from subsidence, slides, and the unexpectedly flat angle of repose of some of the finer material, all of which served to increase the amount of material pumped. Dredging was started in November 1949 and completed in January 1950, just in time to permit the south approach to be used as a job access road.

Fabrication and launching of the tunnel tubes conformed with conventional ship construction practices. The same equipment, building ways and launching technique employed for the production of destroyers in the last war fitted this job perfectly. Consolidated Western Steel Corp. was the contractor.

First the steel shell with stiffener rings was assembled in circular sections about 20 ft wide and partially welded. Each section, known as a "can," was next placed on power-driven rollers and revolved slowly under an automatic welding machine located inside the can. The can was then placed in position on the building ways and hand welded to adjoining cans to form a section about 300 ft long.

Each tunnel section was towed separately from Orange, Tex., where it was fabricated, to the site by two tugs, one forward on the towing bridle and one aft, lashed to the stern. The 113-mile trip on the Sabine River and through the Intercoastal Canal and Galveston Bay was usually made in about 48 hours, depending on wind and tide. The ends of each section were fitted with fenders and other protective devices to minimize damage in case of collision. Seventy-five tons of ballast, in the form of reinforcing steel placed in the bottom of each tunnel section, stabilized it during the voyage.



SCREEDING machine was specially designed for grading tunnel bed under water. Pontoons are firmly anchored to concrete blocks so that they are unaffected by slight changes due to tide or waves. Steel rails are on same slope as bottom of trench. Steel screed rides along rails for about 75 ft, requiring four or five set-ups to prepare trench for each tunnel section.

Tow trips were uneventful except for two incidents. On one occasion, a squall on Galveston Bay made it necessary to head the tow into the wind and lay to under power until the storm had passed, and on another occasion, because of a strong tide, some 40 minutes were consumed in clearing the Port Arthur Bridge, one of the tight spots on the route.

Fortunately the job site permits convenient access from both land and water. The trench cut at the south end of the tunnel was widened slightly to provide sufficient water area for a small harbor clear of channel traffic. The tugs delivered the tunnel sections to this harbor, in which a work pier was constructed along with mooring dolphins. The plant is so laid out that the concrete lining can be poured in three tunnel sections at a time—two from a crane on the pier and the third from a derrick barge. Concrete is placed by the Pumpcrete method, the pipes passing through manholes in the tunnel sections. The pumps are charged by a paving mixer.

This method is well suited to the job as it is necessary in the course of the work to change from manhole to manhole and from tunnel section to tunnel section. Also a section sinks as pouring progresses so that the work must be conducted at different depths of submersion. The dry-batch haul method is used and has proved satisfactory, the aggregate and cement being brought in about one mile by railroad. Steel forms are used where practicable.

The only difficulty experienced has been in placing the roof pour in the tunnel sections. Numerous access holes are cut in the shell for this operation and the tunnel sections are pressure grouted at the ends to fill the final voids.

Work carried out on the tunnel sections in this harbor includes piping, electrical conduits, and roadway slab as well as placement of the concrete lining.

Passing ships have proved to be a disturbing factor but the trouble is not from wave action. Underwater currents started by the slowly turning propellers cause the tubes to move so much that the mooring dolphins have been wrecked at times. During these movements no surface currents or waves are in evidence.

In the tunnel trench, a base course of fine gravel 3 ft deep is being placed to receive the tunnel sections. Placing and screeding of this base course to the design grade is a task requiring a special type of floating equipment. An under-water steel screed is suspended by cables from a traveling carriage mounted over two cylindrical pontoons 100 ft long. The rails supporting the carriage are mounted on supports which can be adjusted to conform to the base-course slope.

Concrete anchor blocks are placed on the trench bottom to fix the elevation of the rig while screeding. Cables between the anchor blocks and winches on the rig make it possible to submerge the pontoons sufficiently to overcome small changes due to tide and small waves. The elevation is then checked and the screed lowered accordingly. Traversing winches, cable and anchors are provided to drag the screed and carriage back and forth as the fine gravel is placed by clamshell bucket. This rig screeds about 75 ft at a set-up and so requires four or five set-ups to cover a sufficient length of trench to receive one tunnel section. The base course is put down and screeded for each tunnel section just before the section is placed.

After all the concrete has been placed in a tunnel section, it still floats with the top about 2 ft above water. Additional weight in the form of ballast is needed to sink it and hold it in position against possible uplift while the sand backfill is placed. The sinking operation would be simplified if the unit weight of the water in the channel were constant but such is not the case, as previously mentioned. Gravity tests of the water at various times and at different depths have indicated that the complete range from salt water to fresh is to be expected. The presence of ship-channel sludge further complicates the problem as the sludge weighs up to 69 lb per cu ft. When designing tackle for lifting the tubes, a fresh-water condition was assumed but when figuring ballast, a heavier liquid was assumed.

Two sinking methods were considered. Under one plan the tunnel sections would be floated into position, tied to anchors or dolphins, and would receive ballast through long pipes. Some device, such as hoists on piling structures, would be provided to lift and pull a tunnel section into position for pinning to the adjacent section. This scheme would have been slow and therefore more vulnerable to dangers from ship traffic. It would have required the men to work in the deeply submerged tubes with only the long pipes for access. Finally, heavy pile structures would have had to be placed along the whole length of the trench to support the hoisting and maneuvering tackle.

In the method finally adopted, the ballasted tunnel section is suspended beneath two barges. The holding lines, through the barges, terminate in a multiple-part tackle leading to steam hoists. Thus both the tunnel section and the barges are towed into position, tied up, and the tube lowered, moved longitudinally and pinned. The first step in this operation is to move the floating tube to a location where the depth is just enough to permit the barges to be floated over a tunnel section while it rests on the bottom. First ballast is added until the section sinks, then the two barges are floated over it and the lifting lines attached. When the tunnel section has been brought up snugly against the bottoms of the barges, the remaining ballast is added.

Calculations showed that it would not be feasible to design the barges and lifting tackle heavy enough to lift, in fresh water, a tunnel section which was ballasted for the ship-channel sludge. Therefore the contractor decided to pump the tunnel trench clear of the sludge and to base the design on fresh- and salt-water conditions only.

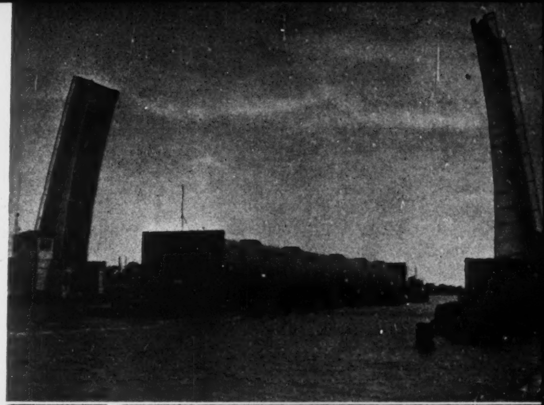
As a 300-ft concreted tunnel section weighs only about 8,560 tons, about 440 tons of ballast is needed to sink it in salt water, and an additional 120 tons of ballast to overcome uplift when backfilling. Thus a minimum of 560 tons of ballast is needed with no safety factor provided. Under this condition the lifting tackle and barges have to handle a total of 400 tons, 100 tons per hoist. A 13-part tackle for each hoist is necessary. This set-up utilizes all the boiler and hoist capacity readily available.

The lack of a safety factor against the possibility that a tunnel section may float out of position is offset by placing concrete block weights in it when it is in position and before backfilling starts. These block weights are removed and re-used, of course, when the backfill has covered the section enough to hold it in place.

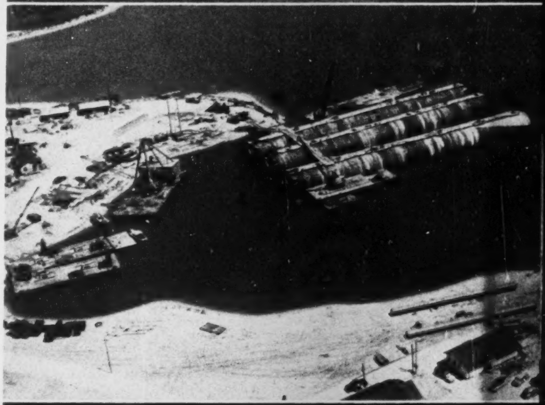
As of February 15, four tunnel sections have been sunk and the closure plates at the joints driven; two joints have been concreted under water; bulkheads have been removed from one joint; and backfilling has been completed as far as possible at this stage of the work.

The most difficult task, that of working in the center of the channel, where the bottom of the trench is 90 ft below water level, and where ship traffic must be suspended at intervals, is yet to come.

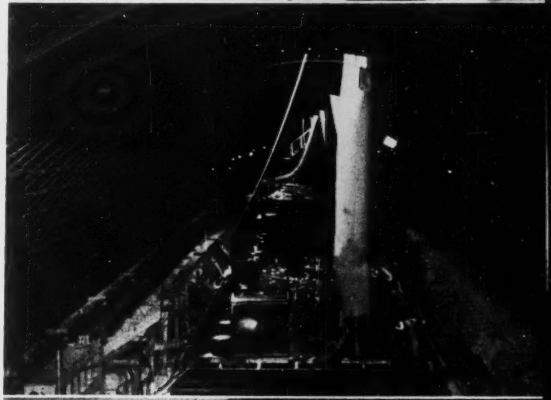
(This article is based on the paper presented by Mr. Anderson before the Construction and Structural Divisions' joint session at the ASCE Houston Convention.)



TUNNEL SECTION clears Port Arthur Bridge on inland waterway, one of narrow spots on towing route. Each tube requires two tugs, one forward on towing bridle and one aft.



CONCRETE LINING is placed in tunnel sections A, B, and C, at Baytown anchorage, which was specially outfitted for job. Sinking scows are being assembled at extreme left of photo. Long tubes on shore in foreground are pontoons for steel screeding machine.



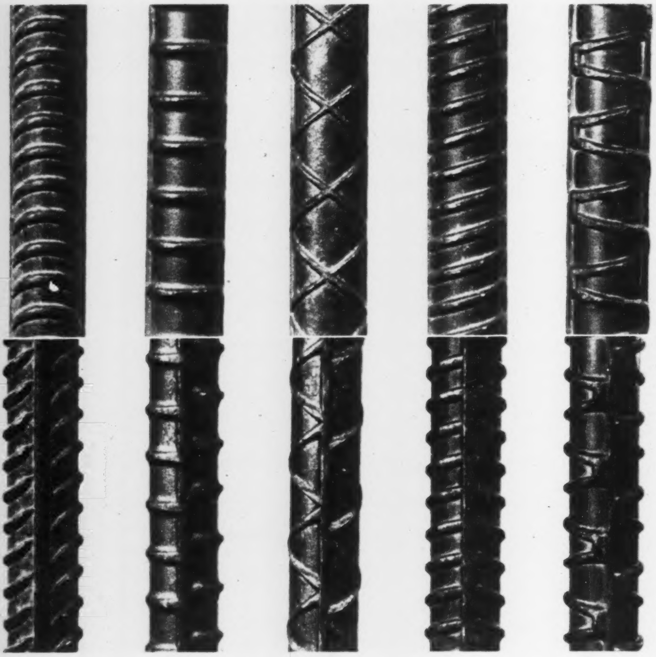
ROADWAY SLAB IS poured in tunnel sections by Pumpcrete method, well suited to job because sections are continually sinking, and pour has to move from manhole to manhole. White ducts in tunnel section provide for ventilation.

THREE PHASES of work on tunnel sections are pictured. Tunnel sections at left are being concreted; section in center, far out, is being towed into concreting pier; and section at right is in position to receive sinking ballast. Sinking scows will transport ballasted tunnel section to site.

NEW REINFORCING BARS with improved deformation patterns, now generally available, have higher unit strength in bond than old types. Usually hooks can be eliminated since better deformations provide improved anchorage. Thus design procedure is simplified and a more economical structure results. Higher allowable stresses were adopted for the new bars in February 1951, as given in Table I on facing page.

Development of these bars was made possible by the fine cooperation among government agencies, technical societies, and producers. Problems encountered and solved are here described by Mr. Willson, who headed the War Production Board's Structural Materials Branch in 1942.

The bars are the result of seven years of work by the Committee on Reinforced Concrete Research of the American Iron and Steel Institute and expenditures in the name of the Committee totaling $300,000 by 19 producers of bars, besides $300,000 of direct costs to these producers for development of new patterns and rolls for bar manufacture.



New deformation patterns improve bond of reinforcing bars

C. A. WILLSON, M. ASCE,

Research Engineer, Committee on Reinforced Concrete Research, American Iron and Steel Institute, New York, N.Y.

IMPROVED DEFORMATION patterns for steel reinforcing bars have been given the stamp of professional engineering approval through actions taken by the American Society for Testing Materials and the American Concrete Institute. The most recent action is that taken by the latter group at its San Francisco Convention in February 1951, when the revised allowable unit stresses for reinforcing bars were formally approved. The work of ASTM in helping to develop the new bars will be described in detail in later paragraphs, as will also that of the American Iron and Steel Institute and the National Bureau of Standards. This project is an outstanding example of cooperation among representatives of government, industry, and the profession within the framework of a professional society—the American Society for Testing Materials in this case.

The Commodity Standards Division of the U. S. Department of Commerce has also approved the new deformation patterns by revising its Simplified Practice Recommendations on Steel Reinforcing Bars, effective August 1, 1950, to be in complete agreement with the new ASTM specifications. The work of the Commodity Standards Division in promoting simplified practice is well known. Simplified practice is a method of reducing waste by eliminating superfluous varieties and sizes in industrial products, accomplished by the Division through the active cooperation of producers, distributers, and users of specific commodities. Simplified Practice Recommendations for steel reinforcing bars have been in use since 1925.

Building Code Changes Coordinated

Action by the American Concrete Institute was essential because corresponding changes had to be made in building codes to assure maximum benefit from the more restrictive provisions of the 1950 ASTM Specifications and the 1950 Simplified Practice

Recommendations. First ACI's Bond Stress Committee made a study of all available data on bond, including the three reports mentioned later in this article (that on footing tests at the University of Illinois, and those on the first and second series of bond tests made by the National Bureau of Standards).

The Bond Stress Committee then formulated and approved a completely new set of allowable unit stresses for bond during the ACI convention in 1949, and these were approved by the ACI Building Code Committee a year later. During 1950 the revisions were reviewed and approved by various administrative committees, culminating in formal presentation and approval at the recent ACI San Francisco convention, as previously mentioned. These new allowable unit stresses are given in Table I.

TABLE I. AMERICAN CONCRETE INSTITUTE ALLOWABLE UNIT BOND STRESSES IN CONCRETE

OLD (1947)	
Deformed bars:	
In beams and slabs (without hooks)	$0.05f_c'$
In two-way footings (hooked)	$0.056f_c'$
In beams, slabs, and one-way footings (hooked)	$0.075f_c'$
Plain bars:	
In beams and slabs (without hooks)	$0.04f_c'$
In two-way footings (hooked)	$0.045f_c'$
In beams, slabs, and one-way footings (hooked)	$0.06f_c'$

NEW (FEBRUARY 1951)	
Deformed bars (without hooks):*	
Top bars†	$0.07f_c'$
In two-way footings (except top bars)	$0.08f_c'$
All others	$0.10f_c'$
Plain bars (must be hooked):	
Top bars	$0.03f_c'$
In two-way footings (except top bars)	$0.036f_c'$
All others	$0.045f_c'$

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* The revised unit stresses shown for deformed bars shall be used only for bars conforming to the ASTM Tentative Specifications for Minimum Requirements for the Deformations of Deformed Steel Bars for Concrete Reinforcement, A305-50T. Deformed bars not meeting these requirements shall be classified as plain bars.

† Top bars are horizontal bars so placed that more than 12 in. of concrete is cast in the member below the bars.

Briefly, these revisions in allowable unit stresses in reinforcing bars recognize the fact that the new types of deformed bars (illustrated on facing page) develop sufficient anchorage by bond alone to correspond to the special anchorage of the old-type bars. Consequently, all deformed bars under the new provisions correspond to the bars with special anchorage under the old provisions, and the ACI Building Code is changed accordingly. Allowable bond stresses for the new-type deformed bars are increased substantially over those allowed for the old-type bars. Top bars—those with more than 12 in. of concrete under them—are assigned lower bond stresses than bars in other positions.

Allowable bond stresses for plain bars (including old-type deformed bars not meeting the requirements of the ASTM A305 Specifications) have been reduced. Such bars must now be hooked to give special anchorage.

Early Deformed Bars Inadequate

The study of bond in steel reinforcing bars for concrete goes back to 1906, when M. O. Withey began his investigations at the University of Wisconsin. In the course of his studies (1906–1908) he found that the bond between concrete and corrugated bars was about twice that between concrete and plain bars. Later tests made by Abrams, Gilkey, Wernisch, Mylrea, Slater, Richart, Davis, and Menzel added greatly to our knowledge. However, before World War II very little use was made of this information because many types of bars having inadequate deformations were still being produced.

In 1942, when the War Production Board was advocating an increase in allowable tensile stress for reinforcing steel from 20,000 to 24,000 psi as a conservation measure, it was found that designers of reinforced concrete ships and barges were using stresses as low as 12,000 psi because of the poor bonding qualities of many of the bars being produced. As a result, the WPB organized a committee representing industry, government, and the technical societies to study the subject. This committee developed one new pattern; two of the steel companies developed new patterns; and two companies made important alterations in their existing patterns.

Experimental rollings of these five patterns were made, and bond tests of $^7/_8$-in. bars were conducted at the National Bureau of Standards. These tests involved the use of both beam and pull-out specimens. Four of the five experimental bars exhibited better bond characteristics than the patterns commercially available, and the design developed by the committee was one of the best.

In the latter part of 1943 the Committee on Reinforced Concrete Research of the American Iron and Steel Institute was organized. This committee, consisting of representatives of 21 of the leading producers of concrete reinforcing steel, engaged the late Roy R. Zipprodt, M. ASCE, as its first Research Engineer. In 1944 and 1945 he held 18 conferences with engineers in major cities of the United States to secure ideas for other needed research in reinforced concrete. Total attendance at these meetings exceeded 400, and many valuable suggestions were obtained. The following subjects for research were among those proposed most frequently:

- Footings
- Bond and anchorage
- Splices and spacing
- Plastic flow
- Diagonal tension
- Torsion in beams
- T-beam flange width
- Ultimate theory of design

TABLE II. DIMENSIONAL REQUIREMENTS FOR DEFORMED STEEL BARS FOR CONCRETE REINFORCEMENT

From 1950 ASTM Tentative Standard Specifications A305

		NOMINAL DIMENSIONS, ROUND SECTIONS			REQUIREMENTS OF DEFORMATIONS		
BAR NO.*	UNIT WT., LB PER FT	Diameter, In.	Cross Sectional Area, Sq In.	Perimeter, In.	Max. Avg. Spacing, In.	Min. Height, In.	Max. Gap, In. ‡
3	0.376	0.375	0.11	1.178	0.262	0.015	0.143
4	0.668	0.500	0.20	1.571	0.350	0.020	0.191
5	1.043	0.625	0.31	1.963	0.437	0.028	0.239
6	1.502	0.750	0.44	2.356	0.525	0.038	0.286
7	2.044	0.875	0.60	2.749	0.612	0.044	0.334
8	2.670	1.000	0.79	3.142	0.700	0.050	0.383
9†	3.400	1.128	1.00	3.544	0.790	0.056	0.431
10†	4.303	1.270	1.27	3.990	0.889	0.064	0.487
11†	5.313	1.410	1.56	4.430	0.987	0.071	0.540

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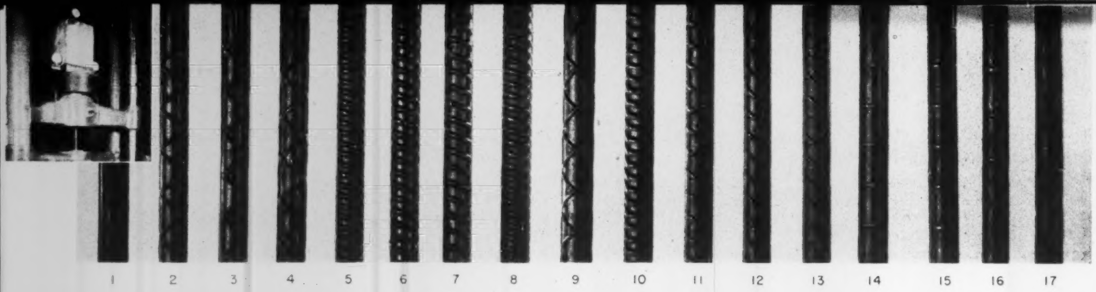
* Bar numbers are based on the number of $^1/_8$ inches in the nominal diameter of the section.

† Bars numbered 9, 10, and 11 correspond to former 1-in. sq, $1^1/_8$-in. sq, and $1^1/_4$-in. sq sizes, and are equivalent to those former standard bar sizes in weights and nominal cross-sectional areas.

‡ Chord of $12^1/_2$ percent of nominal perimeter.



BOND STRENGTH of these 17 bar patterns was tested by pull-out method. Tests were conducted by Arthur P. Clark for Committee on Reinforced Concrete Research at U.S. Bureau of Standards in 1944. Bars numbered 8, 9, 6, 3, 4, and 5 received highest ratings, in that order.

Acting on these recommendations, the Committee established a research project on footings at the University of Illinois in 1944 under the direction of Prof. Frank E. Richart, M. ASCE. One series of tests consisted of 24 wall footings, and the other six series consisted of 132 isolated column footings carrying a short section of column 14 in. square. Most of the footing slabs were 7 ft square, but some rectangular specimens were made. A few tests included the use of welded-bar mats, and several tests were made with a pedestal built in between the column stub and the footing slab.

The major part of the investigation consisted of three series of column footings designed to fail primarily by tension, diagonal tension, and bond respectively—a total of 112 tests. Five types of reinforcing bars were used—two new-style deformed bars, two old-style deformed bars, and one plain bar.

Conclusions Drawn from Tests

From these tests the following conclusions were drawn:

1. Hooks on deformed bars showed no particular advantage over straight bars in resisting failure by bond or diagonal tension when new types of improved deformed bars were used.

2. Diagonal tension seemed to be the most critical factor in footing design.

3. There are advantages to be gained by using welded bar mats or pedestals.

4. The full statical moment—not 85 percent of that value—should be used in design.

This footing project was reported in detail in the American Concrete Institute Journal for October and November 1948.

Early in 1944 the Committee on Reinforced Concrete Research requested ACI's Bond Stress Committee to develop a test procedure for comparing the effectiveness of different types of reinforcing bars in bond. Recognizing that improvement in the bonding characteristics of these bars would be of great benefit to all users of reinforced concrete construction, the Bond Stress Committee immediately began a study of the subject.

After months of work, the members of the group outlined a test procedure involving the use of beam specimens rather than the simpler and less expensive pull-out specimens. Reasons for this decision were as follows: It was believed that the bond developed by an improved deformed bar in a pull-out specimen would not be comparable to the bond actions of the same bar functioning as tensile reinforcement in a beam. The concrete surrounding the steel is subjected to compression in pull-outs and to tension in beams.

Spiral reinforcement is frequently used in pull-out specimens to prevent splitting, whereas no such reinforcement is used in beams. This practice leads to vertical casting of pull-outs while beams are generally cast horizontally. Because of these differences the members of the Bond Stress Committee chose the beam type of test specimen.

Bureau of Standards Tests 17 Patterns

While the ACI Bond Stress Committee was engaged in these deliberations, elimination pull-out tests were being conducted at the National Bureau of Standards by Arthur P. Clark, Assoc. M. ASCE, under the sponsorship of the Committee on Reinforced Concrete Research. Tests of 17 different patterns of deformed reinforcing bars were made to determine their resistance to slip in concrete. Bars were cast in the pull-out specimens in a horizontal position. In certain cases bars were placed near the top of the specimen and in other cases near the bottom. Those cast in the top position were much less effective than those cast in the bottom.

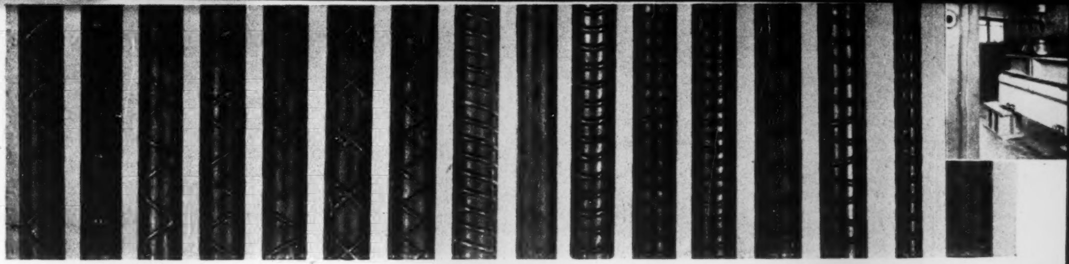
Bars were rated on the basis of their performance through a wide range of slip values taken at both the loaded and the free end of the specimen. The 17 bars tested and rated are illustrated at the top of this page. The tests were reported in detail in the ACI Journal for December 1946.

Bond by Pull-Out and Beam Tests Compared

On completion of these tests in 1946, the Committee on Reinforced Concrete Research immediately authorized the establishment of a more comprehensive program of research on bond. This broader program was conducted at the National Bureau of Standards, also under Mr. Clark's direction, to take full advantage of the knowledge gained from the preceding series. The primary purpose was to determine the bond value of concrete reinforcing bars when tested in beam specimens in accordance with the test procedure developed by the ACI Bond Stress Committee, previously described. Additional objectives were to determine the correlation between the results of beam and pull-out tests made at the same time under identical conditions; to establish the effect of bar size and concrete strength on bond; and to test experimental designs or patterns of deformations developed by reinforcing-bar producers after the preceding series was completed.

The 16 bars tested in this program are shown at the top of the facing page. Comparing this series with the 1944 tests by Mr. Clark, it will be noted that several patterns were eliminated and several new variations added. A plain bar and an old-style deformed bar were included for purposes of comparison. Three mixes of concrete were used having nominal 28-day cylinder strengths of 6,000, 3,500, and 2,000 psi. Three sizes of bar were used having nominal diameters of $1^1/_8$ in., $^7/_8$ in., and $^1/_2$ in. Beam specimens were 8 × 18 in. in cross section, 78 in. long, with a 72-in. span. Pull-out specimens were 8 × 9 in. in cross section and were 8, 12, and 16 in. long to provide a range of embedments.

All specimens were cast in a horizontal position, half with the bar held near the top and half with the bar



THESE 16 bar patterns were tested for bond in beam specimens at National Bureau of Standards in 1946, by Arthur P. Clark. Results corresponded closely with findings from pull-out tests. It was concluded that less expensive pull-out tests can give reliable measure of bond.

held near the bottom. To compare the effectiveness of different patterns of deformations, bond stresses were determined at slips as low as 0.00005 in. at the free end of the specimen and as high as 0.01 in. at the loaded end. The more important results of these tests are as follows:

1. The correlation between results of beam and pull-out tests showed that pull-out tests can give reliable estimates of the bonding efficiency of deformed reinforcing bars.
2. The increase in bond strength obtained by increasing the compressive strength from 2,000 to 3,500 psi is much greater than that obtained by increasing the compressive strength from 3,500 psi to 6,000 psi.
3. The small variations in unit bond strength obtained by using bars of three different sizes followed no particular pattern.
4. Bond strengths obtained with improved bars having increased height or closer spacing of deformations, or both, were much greater than those developed by bars in common use when present-day building-code provisions were written.

Publication of Test Results

A detailed report on the second series of bond tests made at the National Bureau of Standards was published in the Journal of the ACI for November 1949.

Other research projects established under the sponsorship of the Committee on Reinforced Concrete Research are as follows: Longitudinal Distribution of Bond Stress, at Cornell University; Plastic Flow, at the University of Wisconsin; Splices and Spacing of Bars, at Iowa State College; and Diagonal Tension, at the National Bureau of Standards. Reports on the results of these tests will be published and available for distribution in the near future.

Knowledge gained from these research programs made it possible to establish a set of requirements for deformed reinforcing bars that would have superior bonding qualities. Douglas E. Parsons, M. ASCE, of the National Bureau of Standards, took a leading part in developing the first drafts of these specifications. With active cooperation between professional engineers and representatives of government and industry, the first official requirements for the deformations of concrete reinforcing bars were adopted as a tentative standard by ASTM in June 1947. [When Mr. Zipprodt died in June 1947, Mr. Willson succeeded him.]

In these specifications a deformed concrete reinforcing bar was defined as one which conforms to the ASTM Standard Specifications for Billet-Steel, Rail-Steel or Axle-Steel Bars for Concrete Reinforcement, and has lugs, protrusions, or deformations which would inhibit longitudinal movement of the bar relative to the surrounding concrete. Billet-steel bars must be rolled from new billets of properly identified heats of open-hearth or electric-furnace steel or lots of acid-bessemer steel; rail-steel bars, from standard-section tee rails; and axle-steel bars from carbon-steel axles for cars and locomotive tenders in four specified standard journal sizes.

Certain dimensional requirements were also established. The most important of these stated that the maximum spacing of deformations should not exceed the nominal size, and that the minimum height of deformations should not be less than 5 percent of the nominal diameter for the seven larger sizes, nor less than 4 percent of the nominal diameter for the two smaller sizes. Later, on the advice of the ACI Bond Stress Committee, the maximum spacing of deformations was reduced to equal seven-tenths of the nominal size of the bar, and these more restrictive specifications became a 1949 Standard of ASTM.

Round Bars Solve Manufacturing Problems

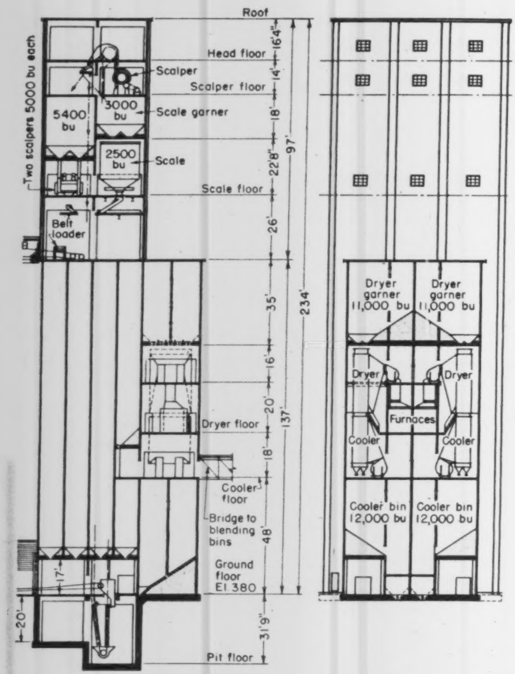
With these stiffer requirements as to height and spacing of deformations, it became evident that it would be difficult to produce the three large-size square bars—1 in., $1\,^1/_8$ in., and $1\,^1/_4$ in.—so provision was made for the production of round deformed bars having cross-sectional areas equivalent to these three large-size square bars. The new bars have diameters of about $1\,^1/_8$ in., $1\,^1/_4$ in. and $1\,^3/_8$ in.

Then came the question of designations. It seemed awkward to refer to a bar as a "$1\,^1/_8$-in. square equivalent round," so provision was made for a numbering system extending from 3 to 11. Bar numbers are based on the number of $^1/_8$ in. included in the nominal diameter. The relationship is exact for the six smaller sizes, 3 to 8, and approximate for the three larger sizes, 9 to 11. The relations between bar numbers, unit weights and nominal dimensions are shown in Table II, taken from the 1950 revision of the ASTM Specifications for the deformations of concrete reinforcement.

Bars meeting these requirements are being produced in a variety of patterns, as illustrated at the beginning of this article. The three basic ASTM Specifications for concrete reinforcing bars, A15 Billet-Steel, A16 Rail-Steel, and A160 Axle-Steel, have been revised to give full recognition to the new deformation specification and the numbering system. With these modifications the deformation specification A305 and the three basic specifications, A15, A16, and A160, became the new 1950 tentative standards of ASTM. These revisions were prepared by Subcommittee V of the ASTM Committee A-1 on Steel.

When completed, these tentative standards were reviewed and approved by letter ballot of the 272 members of the main Committee. Of this total, 142 represent consumers and general interests, and 130 represent producers.

The prompt actions taken by the American Society for Testing Materials and the American Concrete Institute have served to shorten the usual lag between research and practice. The great advances made recently in the development of improved deformed reinforcing bars are being given official recognition of a sort which will permit more intelligent design and more economical construction of reinforced concrete structures.


Roof
Head floor
Scalper
Scalper floor
5400 bu
3000 bu
Scale garner
2500 bu
Scale
Scale floor
Two scalpers 5000 bu each
Belt loader
16'4"
14'
18'
22'8"
97'
26'
35'
234'
16'
20'
137'
Dryer floor
18'
Cooler floor
Bridge to blending bins
48'
Ground floor El. 380
17'
20'
31'9"
Pit floor
Dryer garner 11,000 bu
Dryer garner 11,000 bu
Dryer
Dryer
Furnaces
Cooler
Cooler
Cooler bin 12,000 bu
Cooler bin 12,000 bu

Walls, beams, and columns are all poured by single form

Slip form speedily erects grain building

JAMES W. MACDONALD, JR., Jun. M. ASCE

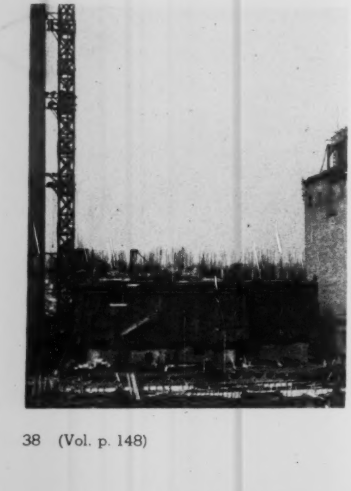
Engineer, Macdonald Engineering Company, Chicago, Ill.

FIG. 1. Cross-sections through combined workhouse and drier (left) and through drier alone (right) show variety of walls, beams, and openings which occur in this type of structure. Floors and bin bottoms (which hang from bin walls) are built later.

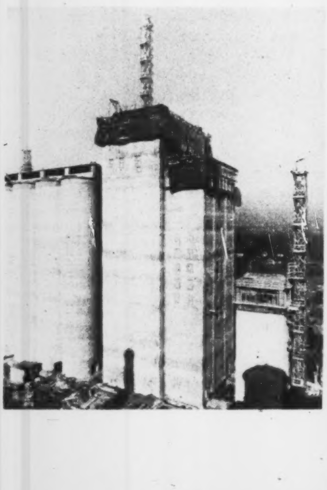
THE IDEA of stripping forms from concrete in four hours, or of pouring a building 137 ft high in which the concrete at the base is only seven days old, is enough to raise the eyebrows of many experienced construction men. Yet practices such as these are commonplace, and in fact essential to the successful use of the sliding form.

Sliding forms are concrete forms which can be raised while the con-

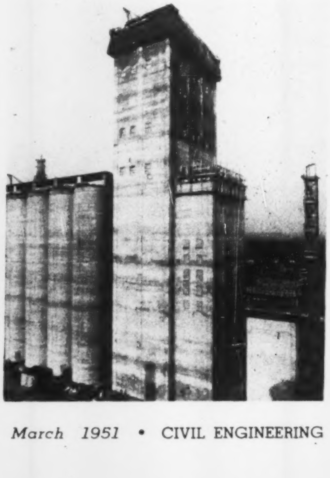
DECEMBER 13 Slip form for workhouse and drier building has completed one day's pour. Walls, columns and beams are all poured in one operation, but floor slabs are poured later.



DECEMBER 23 Drier structure has risen to its full height of 137 ft, while workhouse continues upward. Work was stopped at elevation shown for three-day Christmas week-end.



DECEMBER 30 Workhouse is topped out. Total wall height of 233 ft 6 in. was poured in 14 days and 15 hours, or an average of 8 in. per hour. Weather was close to freezing during most of pour.



crete is still in a plastic state, permitting the continuous pouring of high walls. Originally developed for use in the construction of bulk storage bins, they are used today in a variety of complicated structures. The workhouse of the 2,000,000-bu grain elevator under construction for the General Foods Corp. at Evansville, Ind., is a good illustration of unusual techniques in the application of the sliding form to building construction. The structure (Fig. 1) is 234 ft high and is essentially a multiple-story building whose primary purpose is to house the weighing, cleaning, elevating, and drying machinery for the grain, which is stored in two adjacent groups of round silos. The bins in the building are for use in connection with this machinery. The drier part of the structure is only about two-thirds the height of the workhouse proper.

All walls, columns, beams, and girders above the ground floor were poured with a single sliding form. The floors were poured conventionally later and were either supported on the beams poured in the slip form, or, as in the case of bin bottoms, were hung from the bin walls with long stirrups. Prints, or keys to fit the ends of the slabs, were placed in the outside walls to help carry the floors. These keys were 2 in. deep.

Columns, octagonal in cross section, were formed at the intersection of four walls by providing very large fillets at these points. As the form progressed upward to a point where column loads were substantially reduced, the cross-sectional area of the columns was decreased by placing wood fillers in the form to reduce the length of the fillets between walls.

The slip form was built of timber in one unit. All beams for the various floors were aligned vertically one above another so that no form changes were required as the work progressed upward.

The form is 4 ft high, built of center-matched 1 × 4 timbers vertically and supported by two horizontal wales, each consisting of two or three 2 × 8's (Fig. 2, at right). The ribs of the inside and outside form are held together at intervals of about 8 ft by structural steel or wooden hairpin yokes in which the jack is mounted. The upward thrust of the jack against the yoke is transferred to the form ribs, either through the legs of the yoke or through lift rods.

The construction process is straightforward and simple, but the many tasks that must be done quickly and simultaneously make expert supervision a necessity. The wall forms support a wooden platform or deck at their top edge, which usually extends over the entire area of the building. This platform acts as the working deck for the men who place reinforcing, pour concrete, operate jacks, and set openings. As the deck is an integral part of the form, the men on the deck are raised with the form and therefore are always directly over their work.

Concrete is hoisted in a wooden tower at one end of the structure, spouted to a hopper on the deck, and wheeled across the deck in buggies to the place where it is to be deposited. Reinforcing steel is raised and stored on this deck or on racks above it until placed.

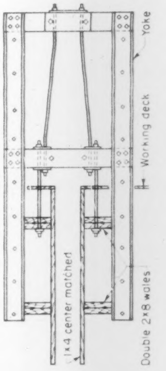
Since the top surface of the concrete is in a plastic state when the next concrete is poured over it, a completely monolithic wall results. This feature is of special advantage in buildings for the storage of bulk materials such as grain, cement, or sugar, where watertightness is essential. At all times the top of the form is kept within 18 in. of the concrete surface (except, of course, at the beginning of operations) so that the concrete can easily be worked with spades or small vibrators.

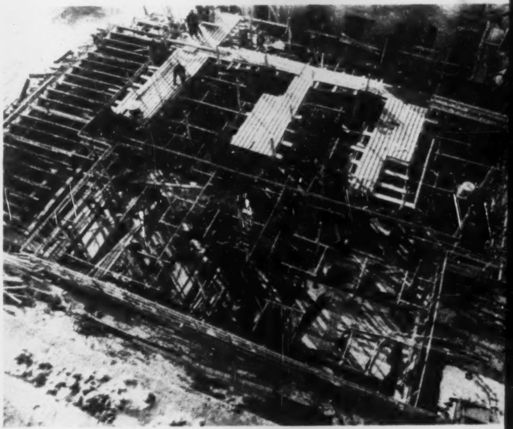
The wall immediately below the form is from 4 to 8 hours old and can be easily finished by rubbing with a wood float without the use of grout. This finishing, done from a scaffold hung beneath the form around the outside of the building, produces a wall of very uniform appearance. For winter work, tarpaulins are hung around the outside of the form and down over the finisher's scaffold. A steam line is run around the building directly under the form, to keep the concrete enclosed by the tarpaulins warm.

Forms Slip Past Windows and Doors

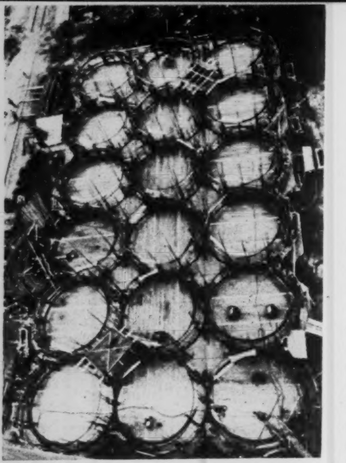
Window openings were framed in wood and set in the walls at their required location. The frames were made the desired size and the same thickness as the walls in which they were to be located, so that the form could easily pass by them after they were set. Channel door frames were also set and concreted into position as the form passed by.

In locations where it was desired to omit a partition between columns, the wall itself was simply blocked out in much the same way as the windows and other openings. It can be seen that if a wall is blocked out for a certain height, then poured for a few feet and again blocked out, the few feet of concrete poured will, in effect, form a beam spanning the distance from column to column. Because of the bulky size of these large blockouts and the interference of jacks and yokes, the blockouts must be solidly built, shored and braced, as the form is jacked past them. The carpenter gang on this work used a finisher's scaffold inside the building for the work that had to be done under the





SINGLE SLIP-FORM for both workhouse and drier structure is erected in position (right). Note filleted corners which form columns of octagonal cross section as form ascends. Yokes seen bracing inner and outer forms across pouring spaces are part of jacking devices. See FIG. 2, left, for typical cross section through wall of sliding form. Timber decking serves as working area for workmen, and rises with form as it is jacked upward.



TYPICAL SLIP-FORM for grain silos provides for pouring 18 silos at one time. Simple shape of silo makes it ideally suited to slip-forming.

STEEL YOKES of jacking devices act as bracing across inner and outer forms. Jacks act against yoke to lift form. Note open area for workmen who are placing steel reinforcing in silo wall.

CONCRETE is poured into forms from buggies, which are loaded by hoppers on form deck. Mix is hoisted to hoppers in timber tower. Jacking speed limits pour to depth of 18 in. at all times, so that concrete can be easily worked or spaded.

form. Where the jack rods had no concrete surrounding them, stiffeners of 4 × 4 lumber were bolted to them to prevent them from buckling.

At El. 137, the drier part of the structure had reached its full height, but the rest of the building, the workhouse section, had 97 ft to go. At this point, the form was stopped momentarily and filled full of concrete. As this was the last concrete required in the drier walls, that part of the form was cut loose from the rest by sawing through the ribs of the three drier walls where they intersected the common wall between the drier and the workhouse. This common wall was now the outside wall of the workhouse for its remaining height. Where the three drier walls were cut off, 4-ft bulkheads were set into the workhouse section of the form. With the form now in two parts, the workhouse section continued to rise, the drier section being left behind.

Rising Speed of Forms Is Important

The speed with which the form is raised is one of the most important variables in this method of construction. If the form is raised too fast, the concrete will not have time to reach its initial set and will fall out below the forms. If the jacking is too slow, the concrete will stick to the form and rise with it. The optimum speed depends on the setting time of the cement and on weather conditions. The form will jack with less effort the greater the depth of concrete that is plastic, but the plastic concrete should not be allowed to get lower than the bottom rib. This depth can be tested from the deck by plunging a reinforcing rod into the concrete and measuring the distance it will penetrate.

Much has been printed about the speed of construction obtainable with sliding forms. It is indeed remarkable to pour a large battery of silos 137 ft high, containing upwards of 5,000 cu yd of concrete, in a little over seven days. Speed, however, is one of the inherent qualities of this type of construction. In addition to depending on the factors affecting the set of the concrete, the speed at which a building can be raised depends on the difficulty of the job and the experience of the crew.

In the early days, before the advent of modern, finely ground cement, 4 ft was considered a good day's work. Average construction speed today is from 12 to 16 ft per day, while 20 ft a day is not unusual. In Corpus Christi, in 1949, with hot weather and ideal conditions, the cement storage silos for the Halliburton Portland Cement Co. were raised their total height of 93 ft 3 in. in 100 hours. This is an excellent record for a single, sustained pour, but greater speeds no doubt have already been made, or if not, certainly will be.

Construction of a building of this type with sliding forms poses many economic problems not usually found in the construction of grain silos. Silos usually have few blockouts and openings and only a small carpenter gang is required. Also, the rate of pouring the concrete is uniform.

In a structure like the Evansville workhouse, however, the concrete pouring rate fluctuates greatly as the form moves from one level of the structure to another. Where bins are located and all walls are being poured, a large quantity of concrete is required and there is very little carpentry work. Conversely, where most of the walls are blocked out, the concrete demand is small and the carpentry work is tremendous. To vary the size of the carpentry and labor gangs with these changes is not practical as they occur frequently and at times which cannot be predetermined exactly. Thus, there are times on this type of structure when labor is not used to its fullest advantage, with a resulting loss in economy. Unit costs on a workhouse may run from 50 to 100 percent more than similar costs on a group of silos, depending on the relative complexity of the two structures.

The sliding form remains, however, the most economical construction method for a building of this type. It is apparent that the necessary form work, shoring and scaffolding necessitated by conventional form methods would be prohibitive.

The economy of the slip form for the workhouse structure was on its own merits for this particular structure and had nothing to do with the fact that slip forms were also used in the silos. There was no reuse of forms from one structure to another. Time was not a deciding factor, but it was a very fortunate benefit obtained with the sliding form.

Macdonald Engineering Co. was the engineer and contractor for these General Foods Corp. structures.

(This article represents a shortened form of the paper presented by Mr. Macdonald before the Construction Division at the ASCE Houston Convention.)

CONCRETE immediately beneath form is finished with wooden float. No grout is needed since concrete in this area is only 4 to 8 hours old.

Radar—
Tomorrow's rain gage

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G. E. STOUT, and F. A. HUFF, Meteorologists,
Engineering Subdivision, State Water Survey, Urbana, Ill.

RADAR, the high-frequency radio device developed during World War II, is now being used by the Illinois Water Survey to detect, track and quantitatively measure rainfall over the northern half of Illinois. Radar's ability to detect and track rainfall was recognized by its military users but has not been deeply explored in the field of hydrometeorology.

Present rain-gaging techniques do not provide the accuracy desired by engineers and meteorologists. On the smaller watersheds under study in Illinois, with gage densities of one gage for 15 sq miles, prior to 1948, large differences in rainfall have been encountered.

These differences have been more pronounced when the precipitation occurred in the form of local showers or thunderstorms, and in Illinois the bulk of the year's precipitation comes from such storms. Even if the density of the network were to be increased tenfold, the details of rainfall from small storms would still be difficult to gage accurately, and the task of collecting and compiling all the additional data would be huge.

When rain-making activities in 1947 boomed forth with great vigor, interest was so great that the Pfister Hybrid Corn Co. of El Paso, Ill., in cooperation with the Illinois Water Survey, organized a scientific program to evaluate the possible benefits of induced precipitation. A war-surplus AN/APS-15 radar set was purchased by the cooperating group to be used for the tracking of both the aircraft and the rainfall during any rain-making attempts.

Although rain-making activities diminished gradually, the utility of the radar unit for portraying the extent of the rainfall area became evident. The quantity of rainfall, it appeared, could also be determined with this equipment. Thus a radar set scanning a radius of 70 miles, or 15,000 sq miles, might give the quantity of rainfall deposited in that area and thereby supplement or even eliminate the standard rain gage.

The principle of radar involves emiting a short, intense pulse of energy which is confined within a narrow beam as it travels outward. If the beam strikes an object, a small part of the energy is reflected and returns as an echo to the point of transmission, where it is amplified and presented on a cathode-ray tube. One standard presentation unit is the PPI scope, or plan-position indicator. The range and bearing of the object are readily determined.

To study the relationship between the radar image and actual rainfall intensities, a dense 31-gage network of weighing-bucket rain gages was established during the middle of July 1950 in the vicinity of Washington, Ill. The network covers the Farm Creek watershed and surrounding area above East Peoria. The gages are generally spaced about $1\frac{1}{2}$ miles apart.

Instead of the standard 8-in. collector, a 12.648-in. collector was used, which expanded the vertical scale $2\frac{1}{2}$ times. The standard drum clock was used with six hourly gears so that one complete revolution covered only a six-hour period. With both these modifications, 5-min rainfall amounts, as well as the 1-min rate of fall, were easily determined with a fair degree of accuracy. The radar station is located 15 miles to the east of the nearest edge of the rain-gage network, on the third floor of the Pfister Building in El Paso, Ill.

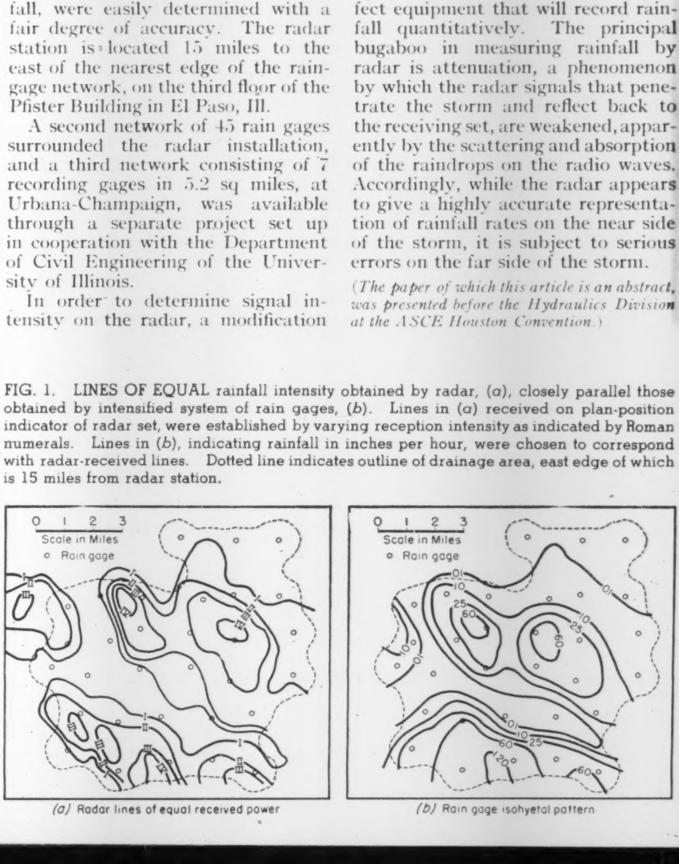
A second network of 45 rain gages surrounded the radar installation, and a third network consisting of 7 recording gages in 5.2 sq miles, at Urbana-Champaign, was available through a separate project set up in cooperation with the Department of Civil Engineering of the University of Illinois.

In order to determine signal intensity on the radar, a modification was built in whereby the received power signal which produced the storm image was amplified stepwise according to a preset pattern. The image variation on the plan-position-indicator scope was then photographed on 16-mm film at a rate of about 6 frames per min. The camera, recording only those areas on the scope within which the signal strength exceeded the threshold of optical perception, was able to obtain, in successive pictures, a complete outline of the entire storm and outlines of increasingly more intense rainfall areas inside the storm (Fig. 1). A total of 8 such intensity steps were provided, but few storms occurred in which rates of precipitation were high enough to cause a return to be recorded at Steps 7 and 8.

It is evident from the Illinois studies that a great many modifications in normal radar design and operation are still necessary to perfect equipment that will record rainfall quantitatively. The principal bugaboo in measuring rainfall by radar is attenuation, a phenomenon by which the radar signals that penetrate the storm and reflect back to the receiving set, are weakened, apparently by the scattering and absorption of the raindrops on the radio waves. Accordingly, while the radar appears to give a highly accurate representation of rainfall rates on the near side of the storm, it is subject to serious errors on the far side of the storm.

(The paper of which this article is an abstract, was presented before the Hydraulics Division at the ASCE Houston Convention.)

FIG. 1. LINES OF EQUAL rainfall intensity obtained by radar, (*a*), closely parallel those obtained by intensified system of rain gages, (*b*). Lines in (*a*) received on plan-position indicator of radar set, were established by varying reception intensity as indicated by Roman numerals. Lines in (*b*), indicating rainfall in inches per hour, were chosen to correspond with radar-received lines. Dotted line indicates outline of drainage area, east edge of which is 15 miles from radar station.



(*a*) Radar lines of equal received power

(*b*) Rain gage isohyetal pattern

Photo Courtesy Houston Chamber of Commerce

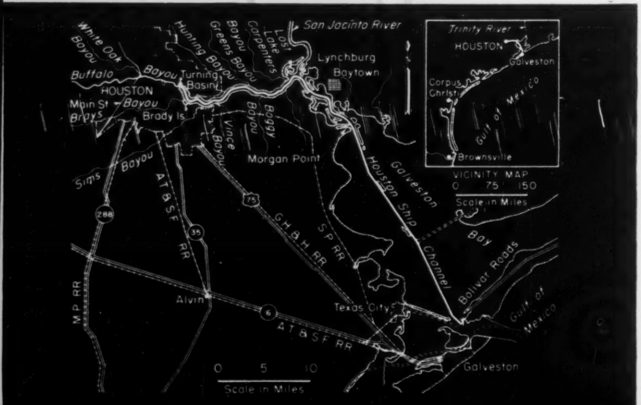
TURNING BASIN, four air miles from center of Houston, accommodates ocean-going vessels and supertankers, which have passed through 50 miles of Houston Ship Channel from Gulf of Mexico. Inland seaport of Houston ranks second to Port of New York in tonnage. For half a century the channel has undergone widening and deepening by pipeline dredging under direction of Corps of Engineers. Where and how to dispose of spoil now constitute serious economic problems.

Dredges enlarge 50-mile Houston Ship Channel

KENNETH HEAGY, M. ASCE

Chief, Engineering Division, Galveston (Tex.) District, Corps of Engineers

FIG. 1. HOUSTON SHIP CHANNEL provides deep-water navigation for distance of 50 miles from Gulf of Mexico to Turning Basin not far from heart of Houston, Tex. Port is second only to New York in volume of tonnage handled. Work begun in 1872 to provide channel 25 ft deep was completed in 1915. Congressional authorization now calls for minimum depth of 36 ft, and local interests are pressing for amendment to this authorization increasing the depth to 40 ft along the lower 46 miles of the channel. Disposal of 50 million more cubic yards of spoil within limits of economical pumping would be involved.


San Jacinto River
White Oak Bayou
Hunting Bayou
Greens Bayou
Bayou Carpenters
Lost Lake
Lynchburg
Baytown
Buffalo Bayou
Turning Basin
HOUSTON
Main St
Brays Bayou
Brady Is
Vince Bayou
Boggy Bayou
Morgan Point
Sims Bayou
288
AT & SF RR
35
75
G H & H RR
S P RR
Houston Ship Channel
Galveston Bay
Bolivar Roads
M P RR
Alvin
6
AT & SF RR
Texas City
Gulf of Mexico
Galveston
0 5 10
Scale in Miles
Trinity River
HOUSTON
Galveston
Corpus Christi
Gulf of Mexico
Brownsville
VICINITY MAP
0 75 150
Scale in Miles

THE HOUSTON SHIP CHANNEL, which was first authorized by Congress in June 1872, has undergone an almost continuous program of deepening and widening to accommodate the ever increasing seagoing traffic. In this program of development, more than 60,000,000 cu yd of new-work material and 112,000,000 cu yd of maintenance material were removed by dredging between July 1927 and June 1950. Disposal of dredge spoil has been a difficult problem along the 25-mile, land-locked section of the channel (Fig. 1).

From Bolivar Roads, where Galveston Bay meets the broad Gulf of Mexico, the Houston Ship Channel extends a total distance of 50 miles to the Turning Basin, which is less than 4 air miles from the center of downtown Houston, and the head of deep-water navigation at one of America's busiest deep-sea ports. Since the founding of the city in 1836, the people of Houston have dedicated their efforts to the development of an inland seaport. In 1948 the shipping which passed through the Houston Ship Channel made the port of Houston second only to New York in the volume of tonnage handled.

Current authorizations by Congress call for a minimum depth of 36 ft throughout the channel and in the Turning Basin. When this present project is completed, the channel will have a minimum bottom width of 400 ft from Bolivar Roads (Mile 0) to 5,000 ft above Baytown (Mile 27); of 350 ft thence to the mouth of Boggy Bayou (Mile 38); and of 300 ft thence to the Turning Basin (Mile 50). In addition, turning points 36 ft deep at the mouth of Hunting Bayou and at the lower end of Brady Island are authorized, together with off-channel silting basins. Above the Turning Basin a light-draft channel, following the course of Buffalo Bayou, extends to Main Street, virtually the center of Houston. Congressional authorization for the light-draft extension calls for a depth of 10 ft below mean low tide over a 60-ft bottom width.

Altogether, approximately $34,250,000 have been spent on the widening, deepening, and maintenance of the Houston Ship Channel. An additional expenditure of approximately $7,000,000 will be required to complete the project to its authorized dimensions. Local interests are requesting the present Congress for an amended authorization to increase the depth to 40 ft, rather than 36 ft, along the lower 46 miles.

SPOIL DISPOSAL IN INDUSTRIAL AREA POSES PROBLEMS AND INFLUENCES COSTS

Houston is an industrial port. Approximately 75 percent of her cargoes emanate from nearly 100 industrial plants and terminals lining the channel or located nearby. The port has a total of 94 wharves, piers, and moorings, of which 70 are used by ocean-going vessels. These wharves, piers, and moorings line the 25-mile stretch of the channel from Morgan Point to the Turning Basin, and the light-draft extension above the Turning Basin.

The industries making the largest contribution to the commerce of this waterway are those engaged in the production of crude oil and the refining of petroleum. Between Morgan Point and the Turning Basin, there are 9 large oil refineries with a combined daily capacity of 416,000 bbl of petroleum products. Other industries include shipbuilding yards, steel smelting and fabricating mills, chemical plants, fertilizer plants, a paper pulp mill, rice mills, synthetic rubber plants, flour mills, breweries, cotton compresses, container manufacturing plants, food processing plants, building material plants, and numerous wholesale, retail and service establishments.

According to the official tonnage statistics of the Corps of Engineers, the cargo moving over the Houston Ship Channel during the calendar year 1948 totaled 38,904,446 short tons, and this volume of commercial shipping can be expected to increase. It follows that further widening, deepening, and easing of bends in the channel and the dredging of additional turning basins in the bayou section will be required to facilitate navigation.

The increase in industrial development along the upper part of the channel has made it difficult and costly to obtain suitable areas for the disposal of materials excavated by pipeline dredges. The areas available for disposal are at some distance from the channel, and to reach them long pipelines and occasionally boosters are required. Hopper dredging may have to be resorted to in the upper part of the bayou section.

The deposit of silt in the Houston Ship Channel has been a matter of grave concern ever since the inception of the project, has required maintenance dredging to prevent serious interference to navigation, and has involved the expenditure of large sums of money. The greater part of the silting in the upper 25-mile length of the channel can be attributed to floods on Buffalo Bayou and the San Jacinto River.

Sediment Reduction Methods Considered

The Turning Basin, a much enlarged and greatly deepened part of the old channel of Buffalo Bayou, varies from 400 to 1,100 ft in width and has a surface area of approximately 50 acres. This basin constitutes a very effective stilling basin. Plans were made, and then abandoned, for a movable dam across Buffalo Bayou where it enters the Turning Basin. Such a dam would raise the water level in the bayou enough to lower the velocity of the water in it and hence reduce bank erosion. Since the annual operation and maintenance of this structure, estimated to cost $1,300,000 to build, would exceed the annual cost of dredging out the yearly accumulation of 200,000 to 300,000 cu yd of silt, this plan was abandoned.

A similar plan for reducing the silt coming in from the San Jacinto River involves the use of control works estimated to cost $550,000, at some point on the lower reach of the river above its junction with the Ship Channel to prevent the further degrading of the bed of the stream to meet the new base level established by the enlargement of the Ship Channel for navigation. Maintenance costs would be in excess of $100,000 annually if the effectiveness of such a silting basin were to be maintained.

The volume of San Jacinto River sediment entering the Houston Ship Channel in suspension in an average year is estimated at 1,300,000 cu yd. At 8 cents per cu yd, an average annual maintenance cost of more than $100,000 can be attributed to sedimentation from this source alone, enough to justify further study of a control structure on the river, above the point where it enters the channel.

The sediment that enters the Galveston Bay Section of the channel between Bolivar Roads (Mile 0) and Morgan Point (Mile 25), comes from the Trinity River, from the shore line and shallow areas in Galveston Bay, and from the spoil banks. Shoaling in the reach from Mile 0 to Mile 10 is comparatively light, but the reach from Mile 10 to Mile 15 is exposed to cross currents and requires about 1,000,000 cu yd of maintenance dredging per year.

Since the difficulties and costs in obtaining suitable areas for the disposal of dredged materials are increasing, it follows that serious consideration must be given to a long-range dredging and disposal plan. In the analysis and preparation of this plan, the channel was considered in four sections (Fig. 1), as follows:

Section 1. Bolivar Roads (Mile 0) to Morgan Point (Mile 25)
Section 2. Morgan Point (Mile 25) to Lynchburg (Mile 34)
Section 3. Lynchburg (Mile 34) to Greens Bayou (Mile 41)
Section 4. Greens Bayou (Mile 41) to and including the Turning Basin (Mile 50)

During the period July 1927 to June 1950, new-work and maintenance dredging was done in these reaches as shown in Table I (next page). Practically all this dredging was done by pipeline dredges. The new-work material removed consisted of silt, sand, and clay from all sections, with some oyster shell in Section 1, and heavy clays in Section 4. The maintenance material removed consisted of silt and sand.

The unit costs in Table I are averages for all work done in the 23-year period. The costs that make up these averages vary over a wide range, as the unit cost of any particular dredging contract depends on the following factors: the total yardage for the job; mobilization and demobilization costs; fuel, labor and plant operating costs; the length of the pipeline and whether the line is floating or laid on land; the elevation to which the spoil must be lifted; the size of the spoil area and the amount of dike work required to retain the spoil on the area; and, perhaps most important of all, the bidding competition.

Section 1. Disposal of spoil from the channel between Bolivar Roads and Morgan Point across Galveston Bay presents no problem, as the material can be excavated by cutter dredge and transported by floating pipeline 2,000 to 5,000 ft back from the channel for deposit in the shoal waters of the bay. Pipeline dredging costs in this reach of the channel have averaged less than 7 cents per cu yd, and present-day costs range between 8 and 10 cents per cu yd. Shoaling in this 25-mile section of the channel averages 3,110,000 cu yd annually.

Section 2. Between Morgan Point and Lynchburg, there is likewise no unusual dredging or spoil disposal problems. With the exception of the Baytown area, there is considerable undeveloped frontage along the channel and no difficulty in laying pipelines to disposal areas. Some of these disposal areas are more than a mile away from the dredging, and land as well as floating lines are required, resulting in an increase in pumping cost as compared with the cost of this work in the Galveston Bay area. Modern dredges are usually designed to pump materials through 6,000 to 7,000 ft of pipeline against a head of 15 ft, and any appreciable increase in length of pipeline or head, affects the efficiency of the plant with a resulting increase in cost. Dredging costs averaged 12.5 cents per cu yd in this reach.

TABLE I. DREDGING QUANTITIES AND COSTS ON HOUSTON SHIP CHANNEL

July 1927 Through June 1950

	New Work			Maintenance		
Section	Cu Yd	Cost per Yd	Total Cost	Cu Yd	Cost per Yd	Total Cost
1	32,536,665	7.32¢	$2,381,699	71,672,086	6.82¢	$ 4,887,928
2	13,980,447	13.36¢	1,868,279	14,710,350	11.76¢	1,730,358
3	4,591,218	13.00¢	597,250	8,379,836	14.41¢	1,207,207
4	8,771,159	18.18¢	1,594,363	17,856,629	23.01¢	4,109,331
Totals	59,879,489	10.76¢	$6,441,591	112,618,911	10.60¢	$11,934,824

Section 3. The problem of suitable disposal areas in the reach from Lynchburg to Greens Bayou is becoming increasingly difficult. From July 1927 to date, approximately 12,972,000 cu yd have been dredged from this reach of the channel. It is estimated that a fill of 9,000,000 cu yd can be placed in the present spoil disposal areas. The authorized widening from 250 ft to 350 ft and deepening from 34 to 36 ft, will require the dredging of about 6,000,000 cu yd. When this work has been accomplished, there will remain about 3,000,000 cu yd of available storage.

Section 4. The reach from Greens Bayou to and including the Turning Basin is critical in regard to the problem of spoil disposal. During the past 23 years, 26,600,000 cu yd have been dredged and pumped into areas as much as 6,500 ft from the channel to an elevation of 45 ft above mean sea level, at an average cost of 21.4 cents per cu yd. The remaining capacity of these areas is estimated roughly at 32,000,000 cu yd. However, the present authorized channel widening from 200 to 300 ft and deepening from 34 to 36 ft will reduce the remaining spoil capacity to about 22,000,000 cu yd.

Effect of Channel Widening and Deepening

Should Congress authorize increasing the project depth from 36 to 40 ft along the lower 46 miles of the Houston Ship Channel, the spoil disposal situation will be materially affected. Supertankers are now being built to carry 250,000 bbl of oil. These vessels are 659 ft long and 85 ft wide, and have a draft of 34 ft $2\frac{5}{8}$ in. If they are used in the coastwise trade the savings from their economical operation might justify a project depth of 38 ft and a widening to 400 ft, or possibly to 500 ft where shore installations permit. To deepen the channel to 38 ft over a minimum width of 500 ft would require approximately 49,000,000 cu yd more of dredging. The problem of spoil disposal from Morgan Point to the Sinclair Refining Co. facilities (Mile 46) would then become of such magnitude as to seriously affect new-work and maintenance dredging costs, since many of the spoil areas would be filled to capacity and the use of long pipelines and booster plants would be inevitable.

The possibility of having the dredge deposit material in barges which would be towed to a disposal basin or to the Gulf of Mexico for dumping was studied. However, the initial and operating costs of tug and barge equipment and the difficulty of maneuvering the dredge and attendant plant in channel traffic precluded use of such equipment.

Hopper dredging would be an alternative method for maintenance but would require the dredging out of rehandling basins. Hopper dredges cannot make final disposal of the dredged material unless an area of deep water is available for dumping. Since there are no such areas along the channel or in Galveston Bay, it would be necessary to dredge out the necessary basins into which the hopper dredge could dump, and from which the material could be pumped ashore by pipeline dredges. Such rehandling basins would have to be near the final disposal area to avoid the use of long pipelines and booster plant, and yet near the ship channel to avoid digging and maintaining long approaches. It is also desirable that rehandling basins be within a five-mile haul of the reach of channel to be maintained.

A large dumping or rehandling basin could be dredged out on the north side of the channel at the mouth of the San Jacinto River (Fig. 1) and a leveed disposal area could be constructed over the Lost Lake area between Old River and the San Jacinto River. This area would hold approximately 23,000,000 cu yd of material and would suffice as a dumping ground for the maintenance of the entire Ship Channel between Lynchburg and the Turning Basin for approximately 20 years. The cost of constructing this basin would be that of removing about 1,000,000 cu yd at 8 cents per cu yd, or $80,000 exclusive of land cost.

Based on the current operating cost and performance of hopper dredges of the *U.S. Harding* type, and the cost of a medium-sized cutter or pipeline dredge, the approximate average cost of dredging the Ship Channel between Lynchburg and the Turning Basin would be 24.3 cents per cu yd for 475,000 cu yd per month, to which should be added 0.4 cents per cu yd to cover the cost of constructing the rehandling basin and the levees for the land disposal area. The resulting total of about 25 cents per cu yd compares favorably with the present-day cost of pipeline dredging when the pipeline length is 12,000 ft and the lift is 25 ft. After channel widening to 500 ft and deepening to 38 ft, the Harris County Houston Ship Channel Navigation District will find it exceedingly difficult to furnish suitable spoil disposal areas for pipeline dredging falling within these limits.

Valued assistance and information in the preparation of this article were furnished by T. W. Elam, Chief, Design Branch; A. B. Davis, Jr., Chief, Planning and Reports Branch; E. H. Brown, Chief, Hydraulics and Hydrology Section; C. F. Baehr, Resident Engineer, Harrisburg Field Office; E. D. Dorchester, Head, Contract Administration Section; and H. E. Schmidt, Chief, Plant Branch—all of the Galveston District, Corps of Engineers.

(This article is based on the paper by Mr. Heagy presented before the Waterways Division at the ASCE Houston Convention.)

Prior planning saves lives in atomic disaster

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Sanitary engineers occupy key position in preparedness program

RESCUE of personnel—saving of lives—is certainly the greatest concern when disaster strikes. If a force such as an atomic bomb is released against one of our large cities, casualties will range from 40,000 to 120,000 persons. At Hiroshima, 80,000 persons were killed, but authorities who have studied that bombing state that about half of these deaths could have been prevented. This possible saving of 40,000 lives indicates why such great emphasis is placed on civil defense planning. An effective basic disaster plan will do much to save lives, alleviate suffering, reduce damage and provide essential services.

The basic plan requires: (1) detailed planning of tasks for maximum use of personnel, materials and equipment; (2) a complete logistical study of all supplies needed; and (3) trustworthy, mutual-aid agreements.

The engineer is faced with serious problems in protecting personnel, reducing property damage and restoring essential services when disaster strikes. He can effectively assist humanity by careful planning and by proper organization. Tasks of engineers should be divided into three periods—before, during and after the disaster. Joining in Civil Defense work for pre-disaster planning is a "must" for engineers if we are to have a practical, workable program. Rescue operations to save lives and alleviate suffering, and other emergency measures are essential during the catastrophic period.

The period immediately following an atomic attack may pose problems of tremendous magnitude to the engineer. Decontamination will have a top priority in ABC (atomic, biological, and chemical) warfare. While BW (biological warfare) and CW (chemical warfare) agents may be used, perhaps radioactive contamination is the one most likely to be encountered.

Nuclear radiations, which produce harmful consequences in living organisms, cannot be detected by the unaided senses. They cannot be seen, felt, tasted, heard, or smelled. There are two general types of radiation: (1) particles, which are minute bits of nuclear matter (neutrons, and alpha and beta particles); and (2) electromagnetic waves, similar to light, heat, and radio waves but of short wave length (the gamma and X-rays).

The ionizing effect of radiation is measured by the roentgen unit (r). The roentgen is based on the amount of X-rays or gamma rays required to produce ions equivalent to one electro-static unit of charge in 1 cc of air under standard conditions. The roentgen measures the amount of energy absorbed by material receiving radiation.

The means available for measuring radiation fall into two general classifications: (1) those that measure the rate of receiving radiations, usually based on ionization of gases, such as Geiger Muller counters and ion chambers; and (2) those that measure integrated dosage or the total amount of radiation energy received, such as the photographic film badges and pocket dosimeters.

The engineer will necessarily depend upon medical personnel and biologists for a determination of how much radiation a person can safely receive. For peacetime work, a limit

TABLE I. PRE-DISASTER CHECKOFF LIST FOR A WATER SUPPLY SYSTEM

Brief criteria by which engineers, administrators and operators can evaluate vulnerability of a water supply system to attack

- I. Maps of Distribution System
  - A. Comprehensive—should include picture of entire water system for wide local distribution, for Mutual Aid Regions and for state control, indicating sections to be blocked off in event of conflagration.
  - B. Large-scale sectional plats—for use in making repairs; should give details for increasing flow and rerouting water.
  - C. Valve records—should include complete information and be located in dispersed places
- II. Training of Operators
  - A. Normal operations—knowledge of where people live; training of recruits in emergency operations.
  - B. Planning for disaster operations
    - 1. Availability of increased flow for fire fighting or washing down contaminated areas
    - 2. Facilities for rerouting water
- III. Plant Operation
  - A. Bottlenecks—such as inadequate pumps, filters, chlorinators, etc.; lack of capacity of wells, intakes or storage reservoirs
  - B. Auxiliary sources of water—make definite arrangements in writing for industrial sources; make periodic tests of lakes, rivers, etc., to be used in case of emergency.
  - C. Power (auxiliary)
  - D. Chemical supplies
- IV. Distribution System
  - A. Proper control—requires adequate number of valves, looped and sectionalized system
  - B. Hydrants—determine best locations (above or below ground)
  - C. Automatic cutoff valves—as needed for emergency control
  - D. Fire flow tests—should be conducted regularly
- V. Emergency Equipment
  - A. For testing for contamination
  - B. For pipe location and leak detection
  - C. Portable or auxiliary—consider availability of military portable purifier units (12,500 gal per day = 5,000 people), contractor's well points, chlorinators, dewatering pumps, etc.
  - D. Materials and equipment for repairs—need for stock piles of materials, including mechanical coupled lightweight steel pipe for emergency distribution lines; need for inventories of supplies.
  - E. Masks and protective clothing
- VI. Disaster Plan
  - A. Chain of command
  - B. Trained people for specific tasks
  - C. Transportation
  - D. Communications
  - E. Warning system to consumers (includes instructions for local disinfection)
- VII. Long-Range Plan
  - A. Availability of water for fire protection (capacity of facilities)
  - B. Covered storage areas—should be provided
  - C. Condition of equipment—should be capable of high-speed continuous operation, and should be duplicated and segregated.
  - D. Pumping plants—should be fireproof and bombproof, otherwise equipped with splinter proofing or blast walls.
  - E. Auxiliary water sources—need for cross ties
  - F. New construction and major repairs must be integrated for over-all benefits. (Remove bottlenecks and weak spots first.)
- VIII. Temporary Water Service (2 to 5 gal per capita per day)
  - A. Tanks and containers to be provided at source and points of use
  - B. Tank trucks—must plan for use of, as considerable effort is required to clean gasoline trucks for drinking water.
- IX. Plant Protection
  - A. Against sabotage—loyalty check on operators, identification system, fences, etc.
  - B. Warfare—protective concealment, dispersion, blast walls
- X. Wartime Laboratory Control
  - Detection and measurement of radioactive hazards and of chemical and biological warfare agents are difficult and require radio-chemistry apparatus and specialists.

of 0.3 roentgen per person per week is the accepted standard. (1 roentgen = 83.8 ergs absorbed by 1 gram of dry air.) For mixed radioactive wastes in air which is breathed, the limit of radioactive material is 2 × 10^{-10} microcuries (1 microcurie = 37,000 disintegrations per second). For drinking water, the limit is 4 × 10^{-6} microcuries per cc. Waste disposal is permitted at much higher rates, which are influenced by many factors, such as dilution of sewage and wind direction when the waste is incinerated.

Wartime and disaster radiation limits have not been definitely established. Controversies still rage about how the American will react to relatively heavy exposures. For external radiation, however, certain levels have been fairly well established. It is usually accepted that a dose of 400 r of radiation received over the whole body in the course of a few minutes would be fatal to about 50 percent of the human beings exposed. The 100 percent lethal dose is usually listed as 600 r under the same conditions. Moderate doses of from 100 to 300 r are not considered fatal and were common at Hiroshima and Nagasaki, where most of the people so dosed were casualties but survived.

Single exposures of from 25 to 100 r over the whole body may produce mild or indefinite symptoms of sickness (nausea, vomiting, loss of appetite, malaise). Using 100 r as a median sickness dose, then 50 r may be established as an upper limit for permissible, one-shot radiation in time of disaster.

This 50-r emergency limit is tacitly substantiated by the preliminary report of an Atomic Energy Commission project at the School of Medicine of the University of California, at Los Angeles, under the supervision of Dr. Stafford Warren. The report suggests that 50 r be used as a limit over a 56-day period, and bases the dosage on decay phenomena of an A-bomb explosion.

Internal radiation is another hazard to consider. Where the presence of radioactive dusts is suspected, protective clothing must be worn. This includes full coverage of the body, hands, feet, hair, and some type of mask, either Bureau of Mines approved breathing apparatus of the self-contained type, or if this type is not available, an all-service type such as Army gas mask, Mark IX.

In addition to inhalation, radioactive substances enter the body by ingestion and through breaks in the skin. Careful precautions must be taken constantly under suspected conditions.

How to Decontaminate

Knowing what the radiation hazard is, how can decontamination be effected? Since man cannot influence the rate of radioactive decay, decontamination means removing the radioactive particles to safe locations or waiting until decay has reduced the hazard to permissible limits.

Washing down is an effective means of decontaminating ships. This method was used by the Navy on the *USS New York* and other ships at Bikini, where the under-water explosion showered them with radioactive material. On shore, however, washing down leaves the sanitary engineer with the unpleasant prospect of "hot" sewers. The radioactive material might thus become concentrated and therefore more hazardous, so that the entire sewer system might have to be abandoned, or at least repair would be rendered costly and complex. Much careful study still remains to be done in this whole field of surface decontamination by washing down and other methods.

Radioactive Decay Rates

The spontaneous change taking place in unstable nuclei is known as radioactive decay and proceeds at a characteristic rate which cannot be changed. Natural decay is most important in decontaminating areas. If the radioisotopes are known, or if the rate of decay of mixed isotopes is known, the hazard can be computed for stated time intervals. Decontamination depends on the urgency of need for a facility. If salt water from the explosion of an A-bomb under water has drenched a water supply pumping plant, radioactive sodium (Na) and chlorine (Cl) and fission products might be expected. Assuming a reading of 100 r per hour, and that Na^{24} was the radioactive element (which has a half-life of 14.8 hours), in 30 hours the rate would be 25 r per hour; in 59 hours, 6 r per hour; and in one week, a negligible 0.05 r per hour. If the chlorine is Cl^{38}, its half-life would be 37 minutes and the combined radiation would be less than that given for the Na isotope above. These examples give a rough idea of the decontamination accomplished by time alone. Other factors (fission products, different isotopes of Na and Cl, or other elements) will complicate the actual condition.

Use of Complexing Agents

Still another reason for desiring to know the elements that are radioactive is that one element or a few elements causing the most activity might be removed by selective techniques. The substances used in removing these elements are called complexing agents. They form soluble complex ions with the radioactive elements, have a greater affinity for the radioactive element than for the surrounding materials, and thereby provide a means for removal.

Much research has been conducted by the Navy to find compounds or ions which form complexes with the fission products and with the fissionable material constituting the atomic explosive. The rare earth elements and yttrium are believed to be responsible for 30 percent of the radio activity remaining over long periods. Tri sodium phosphate, or commercial boiler compounds of similar structure, have been found to be fairly satisfactory and cheaper than many compounds used in cleaning operations at Bikini. Because of the large quantities involved in a large-scale decontamination program, complexing agents may be impractical and limited to small areas or to equipment that is urgently needed.

If contamination of the water supply is not too severe, it is probable that such natural factors as dilution by flow, natural decay, and adsorption may render the water fit for drinking within a reasonably short time. In surface water, radioactive contaminants will tend to be adsorbed by the suspended and colloidal matter that is invariably present. This matter will partly settle or be adsorbed by the walls and bottom of the reservoir. In urban water systems, radioactive material escaping adsorption in the reservoir itself may be picked up on the surfaces of the distribution system, which usually consist of highly adsorbent masonry or rusted iron. When, in addition, the purification process includes flocculation, sedimentation and filtration, it is expected that very little radioactive

TABLE II. HUMAN TOLERANCES OF RADIOACTIVITY IN DRINKING WATER

Following an atomic bomb explosion

(In curies per cc)

	Safe Concentration	Low Acceptable Risk
Beta Gamma activity		
For 10-day use of water	3.5×10^{-9}	9×10^{-8}
For 30-day use of water	1.1×10^{-9}	3×10^{-8}
Alpha activity		
For 10-day use of water	2×10^{-10}	5×10^{-9}
For 30-day use of water	6.7×10^{-11}	1.7×10^{-9}

material would be likely to reach the consumer.

Because of the adsorptive properties of soil and its ion-exchange properties, underground sources of water are generally safe from contamination. For this reason, moderately deep wells, even under contaminated ground, can be used as sources of drinking water if surface drainage of contaminated material is prevented.

It has been possible here to consider only briefly the multitudinous problems that would face sanitary engineers after an atomic attack. But it should be emphasized that immediate preparedness is necessary, so that no catastrophe will be able to weaken our country to a point where it can be defeated, thereby allowing the forces of evil to destroy the free way of life.

Three steps are essential now:

I. Sanitary engineers must familiarize themselves with nuclear physics; they must understand its radiations, its hazards and its promise. Peacetime applications will thereby be increased, and the nation's safety will not be jeopardized if an attack comes.

II. Sanitary engineers must adopt standards for permissible contamination and procure instruments for measuring degrees of radiation.

III. Sanitary engineers must participate in disaster relief planning at the community, city, state, and federal level so that protection of public health can be properly handled.

(This article is an abstract of the paper presented by Commander Marsh before the Sanitary Engineering Division session at the ASCE Houston Convention.)

ENGINEERS' NOTEBOOK

Aerial stockpile inventory cuts costs 25 percent

EDWARD F. SHEEHAN, General Superintendent, Construction Division, Philadelphia Electric Company, Philadelphia, Pa.

THIS YEAR a new aerial method was utilized by the Philadelphia Electric Co. to take stock of its fuel on hand at ten different locations. The new procedure of taking inventory from the air proved accurate within 3 to 5 percent, provided the inventory figures in a matter of days instead of weeks, and cut the inventory costs by 25 percent. The company's total coal stock is more than 500,000 tons, and some of the stockpiles contain 85,000 tons.

The company knew that aerial mapping had been used successfully for reservoir studies, transmission-line locating surveys, and for distribution maps. Why not to check coal stocks?

Accordingly, the utility asked Aero Service Corporation of Philadelphia to look at costs and time schedules. It was determined that a single pair of aerial photos would provide the coverage needed for each site, and that the necessary photo flights could be executed in a few hours. Ground control required four elevation points and two horizontal points for each location. Compilation of the topographic maps with precise optical machines would require a week or 10 days after completion of photography and field control.

When the company gave the green light to the project, the photo flight was scheduled for the next clear day. On the day of the flight, the utility's personnel were notified to be on watch for the survey plane, so that the exact time the inventory photos were made could be recorded, an important factor in later computations. The 'plane flew over at an altitude of 1,200 ft.

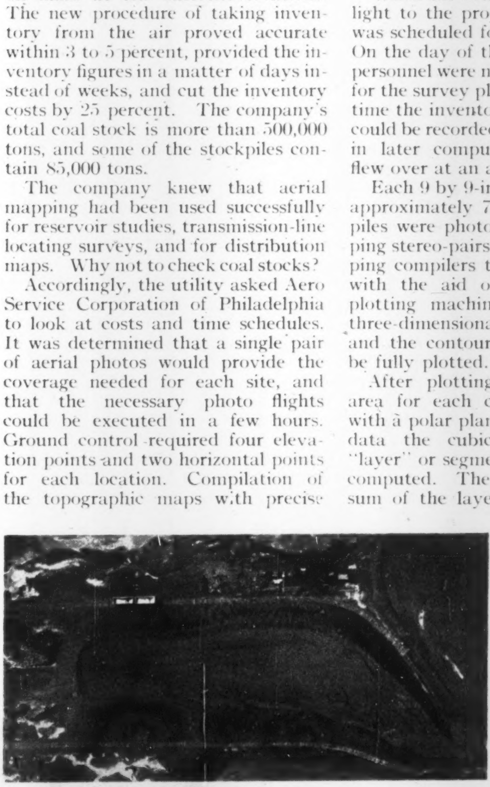
Each 9 by 9-in. aerial view covered approximately 75 acres. The stockpiles were photographed by overlapping stereo-pairs, which enabled mapping compilers to trace the contours with the aid of a special stereoplotting machine. In this way, a three-dimensional view is obtained, and the contour at each height can be fully plotted.

After plotting is completed, the area for each contour is measured with a polar planimeter. With these data the cubic volume for each "layer" or segment of the pile can be computed. The total volume is the sum of the layers. Since computation is made from peak to base in sequence, it is self-correcting, and the total possible error for each pile is within 3 to 5 percent.

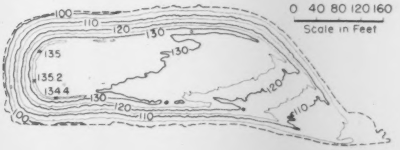
The aerial photos, contour maps, and the results of the computations for each stockpile were delivered to the Philadelphia Electric Co. To establish the tonnage for each pile, the company determined the unit weight of the coal by sampling.

Costs for such work vary according to the size of the areas to be mapped, locations, airport facilities, scheduling, and other factors. But even when only a few stockpiles are mapped, some savings will be possible. In addition to the advantages of speed and accuracy, the aerial method of taking inventory releases many engineering man-hours for other essential work.

According to Aero Service engineers, aerial mapping could be used to tally ore stockpiles or to inventory spoil banks, should reworking be planned. It has been used to tally the amounts removed from open-pit mines, and an air survey of a "stockpile" of logs is now in progress.



CONTOUR MAP of coal stockpile, prepared from overlapping (stereoscopic) pair of aerial photographs, yields area of pile by polar planimeter. Petty Island stockpile shown is one of ten belonging to Philadelphia Electric Co., all inventoried by air on the same day, to accuracy within 3 to 5 percent. Pile contained 95,440 cu yd.



Mercury switch permits use of unlimited number of electric strain gages

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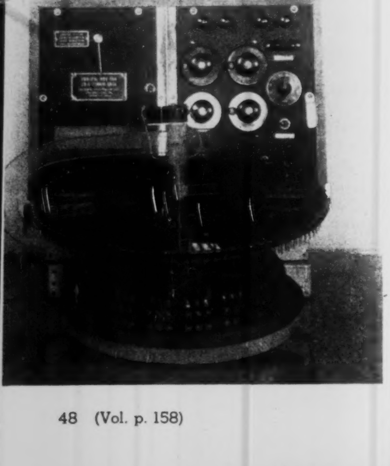
AN EASILY constructed mercury switch developed at West Virginia University permits the use of any desired number of SR4 electric strain gages with a single galvanometer.

Several problems are encountered when using a large number of electric gages. Only one gage at a time can be connected to a galvanometer. Furthermore, it is essential that all lead wires remain fixed in position during a test, and that the resistance of all circuits remain unchanged. The measurement of strains under a single load increment is apt to take eight hours or more. A zero reading for each gage must be obtained, followed by a load reading, and finally a check on the zero reading when the load is removed. The contacts of a conventional type of switch would be burned sufficiently at each throwing to appreciably change the resistance of the circuit.

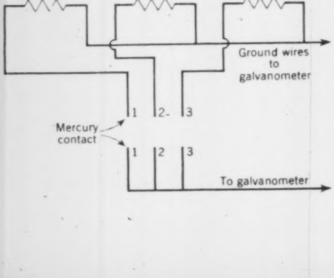
The wiring diagram of the mercury switch designed to overcome these difficulties is given in Fig. 1. All the ground wires from the strain gages may be fastened together and connected to one side of the galvanometer. The other wires from each gage connect separately to the row of screws at the base of the switch. From these points wires extend up through the top of the switch, then radiate toward the circumference, coming in contact only with the circular sheet of bakelite. The leads are then bent and extended downward through holes near the circumference of the bakelite plate. At a distance of 3/16 in. radially outward, another set of wires project downward through the bakelite and are soldered at the top to a common, circular lead which is visible in the photograph. The common lead in turn is connected to the outer terminal of the galvanometer.

The circuit is closed by immersing any two corresponding leads in a small container of mercury. The mercury container is connected to a U-shaped bakelite arm pivoted at the center of the switch. A peg-and-slot arrangement prevents the arm from being raised unless the container is immediately below two corresponding leads. A commercial circuit breaker may be seen at the top of the center pivot. Its purpose is to break the galvanometer circuit as soon as the mercury container begins to descend, thus protecting the instrument. The wooden frame is covered with bakelite because the variable moisture content of wood might be a source of error.



MERCURY SWITCH (left) designed at West Virginia University permits use of any desired number (up to 100) of SR4 electric strain gages with a single galvanometer.

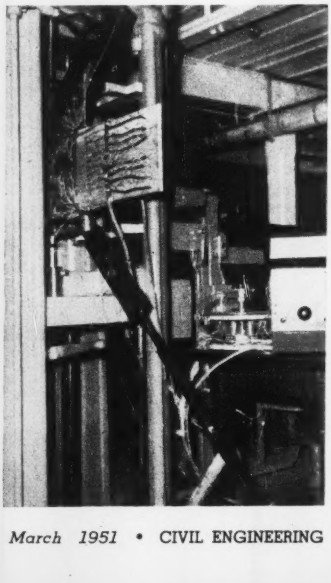
FIG. 1. WIRING DIAGRAM (below) shows three points on 100-point mercury switch. Secondary circuit breaker is provided to protect galvanometer.



During a test, the switch permits all leads to be securely fixed in position with only the mercury container in motion. Mercury was used because of its low resistance and negligible evaporation rate.

The switch has been used with 25 SR4 rosettes and 12 separate SR4 gages to measure strains in a rectangular aluminum gusset plate. Another photograph shows the plate in a 400-kip Olsen testing machine. In 85 percent of the test readings, close zero checks were obtained after the load was removed. Copper wire was used, but this material was not entirely satisfactory as the terminals corroded rapidly. It was necessary to clean the terminals of the switch thoroughly each time before reading the galvanometer.

STRAINS in rectangular aluminum gusset plate are measured in 400-kip Olsen testing machine by means of 25 SR4 rosettes and 12 SR4 gages. Mercury switch stands on table at left of galvanometer. In 85 percent of test readings with this setup, close zero checks were obtained after load was removed.



THE READERS WRITE

Simple Curve Developed for Critical Depth in Trapezoidal Channels

TO THE EDITOR: In the December 1950 issue, Prof. Steponas Kolupaila reviews the problem of critical depth in trapezoidal channels, concluding with his own diagrammatic solution. His solution certainly represents an improvement over antecedent attempts as outlined in his article. It has, however, the disadvantage of requiring interpolation for the side slope of the channel. A little more juggling will reduce the solution to a single curve. In brief review, the basic equation for critical flow in any channel may be written:

$$\alpha Q^2/g = A^3/B$$

where α is the Coriolis coefficient; Q, the discharge rate; g, the acceleration of gravity; A, the cross-sectional area; and B, the top width. For a trapezoidal cross-section,

$$A = (b + md)d \quad . . . . (2)$$
$$B = b + 2md \quad . . . . (3)$$

where b is the bottom width; m, the side slope of the section; and d, the depth. It might be well to point out that when the side slopes on a given section are unequal, m may be taken as the average of the two.

From Eq. 3, it follows that

$$d = (B - b)/2m;\ md = (B - b)/2;\ b + md = (B + b)/2$$

whence Eq. 2 becomes

$$A = (B + b)(B - b)/4m = (B^2 - b^2)/4m. \quad . . . . (4)$$

By combining Eqs. 1 and 4,

$$\alpha Q^2/g = (B^2 - b^2)^3/(4m)^3B$$

which transforms to

$$4m(\alpha Q^2/g)^{1/3} = (B^2 - b^2)/B^{1/3}. \quad . . (5)$$

Equation 5 lends itself to nomographic solution which, however, is hardly worth the trouble, for when Eq. 5 is divided by b^2, it follows that

$$4m(\alpha Q^2/gb^5)^{1/3} = (B^2/b^2 - 1)/(B/b)^{1/3} \quad . . . . . (6)$$

which solves the problem with a single curve, Fig. 1. In fact, for large values of B/b, Eq. 6 reduces to

$$B \approx (64m^3\alpha Q^2/g)^{1/4}. \quad . . (7)$$

which might conceivably be applicable where m/b is relatively large.

Professor Kolupaila's illustrative problems will be used to demonstrate use of Fig. 1. See Table I for data.

Example 1: $Q = 200$ cfs; $b = 6.00$ ft; $m = 1.50$; $\alpha = 1.1$; $g = 32.2$ ft per sec per sec. Find:

$$4m(\alpha Q^2/gb^5)^{1/3} = 4 \times 1.5(1.1 \times 200^2/32.2 \times 6^5)^{1/3} = 3.36$$

whence $B/b = 2.33$ from Fig. 1, and

$$d = (B/b - 1)b/2m = 1.33 \times 6/2 \times 1.5 = 2.66 \text{ ft}$$

Example 2: $Q = 5.00$ cu m per sec; $b = 2.00$ m; $m = 1.5$; $\alpha = 1.1$; $g = 9.81$ m per sec per sec. Find:

$$4m(\alpha Q^2/gb^5)^{1/3} = 4 \times 1.5(1.1 \times 5^2/9.81 \times 2^5)^{1/3} = 2.66$$

whence $B/b = 2.10$ from Fig. 1, and

$$d = (B/b - 1)b/2m = 1.10 \times 2/2 \times 1.5 = 0.733 \text{ m.}$$

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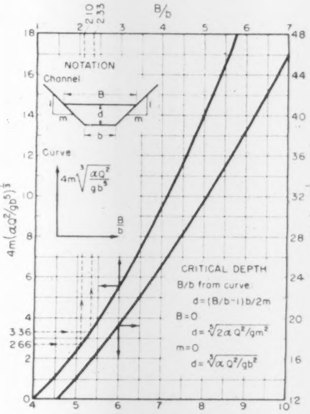

FIG. 1. SINGLE CURVE solves problems of critical depth in trapezoidal channels. Dotted lines indicate solutions to Examples 1 and 2.

TABLE I. DATA FOR FIG. 1 BASED ON EQ. 6

B/b	$[(B/b)^2 - 1]/(B/b)^{1/3}$
1.0	0.000
1.5	1.092
2.0	2.381
2.5	3.868
3.0	5.547
3.5	7.410
4.0	9.449
4.5	11.660
5.0	14.035
5.5	16.570
6.0	19.261
6.5	22.103
7.0	25.091
7.5	28.226
8.0	31.500
8.5	34.913
9.0	38.460
9.5	42.141
10.0	45.952*

* Beyond this value Eq. 7 is in error by less than 1 percent.

Critical Depths Determined by Handbook Tables

TO THE EDITOR: The article, "Universal Diagram Gives Critical Depth in Trapezoidal Channels," by Mr. Kolupaila in the December issue, is interesting.

Tables 124 and 125 in the third edition of the *Handbook of Hydraulics*, by King (McGraw-Hill) can be used conveniently for solving problems such as those given in this article. Using the same examples:

1. **English units.** Given $Q = 200$ cfs; $b = 6.0$ ft; $m = 1.5$; $\alpha = 1.1$.

$$K = \frac{Q\sqrt{\alpha}}{b^{5/2}} = \frac{200 \times 1.05}{88.2} = 2.39$$

Interpolating in Table 125 (King) for $m = 1.5$,

$$Dc/b = 0.447 \text{ and } Dc = 6.00 \times 0.447 = 2.68 \text{ ft}$$

2. **Metric units.** Given $Q = 5.00$ cms; $b = 2.00$ m; $m = 1.5$; $\alpha = 1.1$

$$K = \frac{1.81Q\sqrt{\alpha}}{b^{5/2}} = \frac{1.81 \times 5.00 \times 1.05}{5.66.} = 1.68$$

Interpolating in the same Table 125,

$$Dc/b = 0.367, \text{ and } Dc = 2.00 \times 0.367 = 0.734 \text{ m.}$$

Greater precision is possible with these tables than with diagrams, although such precision may not be necessary for these problems.

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Rio de Janeiro, Brazil

Charts for Critical Depth in Trapezoidal Channels

To the Editor: Prof. Steponas Kolupaila's article in the December issue contains an interesting and instructive review of the various efforts that have been made to obtain a simple solution for critical depth in trapezoidal channels. In commenting on my article, "Dimensionless Constants for Hydraulic Elements in Open-Channel Cross-Sections" (Civil Engineering, October 1948, p. 47), Professor Kolupaila states correctly that the diagram for critical depth is for the foot-pound system only. He also states that it is not clear why the dimensionless procedure was abandoned.

Further reference to my article will show that a dimensionless expression for the critical depth is given in Eq. 4, the left-hand member having the dimensionless form,

$$\frac{Q_c}{b^{5/2}} \frac{1}{\sqrt{g}}$$

However, to facilitate practical applications, Eq. 5 uses the form, $\frac{Q_c}{b^{5/2}}$ The resulting chart for critical depth (Fig. 3) does have the disadvantage of being applicable only in the foot-pound system of units but, as a slide-rule operation (division by $\sqrt{g}$) is eliminated, time is gained in repeated applications. It would be a simple matter to work up a second chart for metric units.

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Cooperative U.S.G.S. Program Improves Design of Bridge Waterway Areas

To the Editor: The article by Mr. Yule on "Bridge Waterway Area Formula Developed for Indiana," in the October 1950 issue, describes a method of design that may have limited application but seems inadequate in several ways:

1. It requires use of a coefficient to express topographic influences that at times may be quite complex, and two competent engineers would select greatly different values.

2. It assumes that a bridge not damaged by a major flood is properly designed, whereas such a structure may be wastefully overdesigned.

3. It does not take into account the mass of factual stream-flow data that has been accumulated in the past 25 or more years. Any sound design should consider the flow of the stream.

In building any bridge, the engineer must try to minimize economic losses from two extremes: He may build either too strong and wastefully expensive, or too weak, risking loss of property and life. In avoiding one error, he often commits the other. The most economical structure would be somewhere between the two extremes and such a structure might be destroyed by a major flood.

Sound design requires a knowledge of three basic factors:

1. Magnitude and frequency of floods at the site. From a flood-frequency curve the design engineer can determine the discharge corresponding to a selected frequency. What frequency is used depends upon policy; a bridge on a primary highway may be designed for, say, a 50-year flood while one on a farm-to-market road may be designed for only a 10-year flood.

2. Relation of stage to discharge. After the design discharge has been selected, it is important to know just how it fits the section of stream channel involved. The cross-sectional area under the bridge, to be effective in carrying water, must be below the elevation of the water surface at the design discharge.

3. Physical and hydraulic characteristics of the stream channel. A study of these characteristics will show how the discharge is distributed both in the approach channel and under the proposed structure. One square foot of cross-sectional area in the center of the main channel, where approach velocity is high, will carry much more water than the same area on top of the bank where the water is shallow, the bank covered with trees and brush, and the approach velocity low. Effects of channel contraction due to bridge piers, abutments and approach fills, usually measured in terms of backwater, can be calculated from a knowledge of the physical characteristics of the channel.

Many state highway departments recognize the value of this relatively new and more rational method of designing bridge waterways, and about twenty of them, including the Indiana State Highway Department, now cooperate with the U.S. Geological Survey in a program designed to furnish hydraulic information tabulated to fit the particular needs of the highway department. Stream-flow records are obtained at fixed gage sites, and although it is not often that a bridge is built at or near one of these places, means have been developed for applying this spot information to specific areas and thus making it available for any bridge site in those areas. This new method should result in better bridge design.

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World Cooperation Urged to Curb Aggression

To the Editor: The present aggression in Korea, however it comes out, will not be the last. We must prepare ourselves for similar crises.

The friendliness of the anti-communist nations has been demonstrated in the present Korean crisis, but the problem of maintaining and spreading democracy still remains. To solve this problem, the people of democratic countries must come closer together, and one effective way to do so is through technical and scientific organizations. Such societies in different nations should join hands, have closer ties and thus help stop communist aggression.

Among such organizations is the American Society of Civil Engineers, whose members are spread all over the world. The writer feels that this society should extend its sphere of activities outside the United States, taking its cue from the United Nations. If possible, it should hold conventions outside the United States. It should divide the world into zones, have zonal centers and zonal secretaries, who would arrange for visits of eminent engineers, including those of the United States, to countries within their zones and be responsible for maintaining contacts with other Society members.

As engineers are the builders of nations, such contacts would go a long way toward creating better understanding between nations. Through collective action much could be done in a short time. The world is full of confusion, suspicion and unrest. We as engineers must destroy distrust by expanding our activities to cover many nations instead of confining our efforts to our own country alone. This can only be accomplished by preparing a program on a realistic basis.

Admittedly Asia will play an important role in future world events. Peace in Asia is a vital factor in the peace of the world. Lasting peace cannot be expected unless undeveloped countries are developed. Our Society can contribute a great deal to this end. Let us then take the initiative and go forward from the planning stage to that of practical action, and quickly. When world contacts between individuals and groups have been firmly established on a realistic basis, no country can fall under communist domination.

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SOCIETY NEWS

President Gail Hathaway Addresses Houston Convention, February 21-23

Engineering contributions to international understanding were stressed by newly elected ASCE President Gail A. Hathaway in talks given at the Houston Convention of the Society, which attracted an attendance of 1,000 engineers and their families from all over the country. In both his initial address as Society President at the Wednesday morning business meeting and in the principal talk at the Thursday Rotary luncheon, Mr. Hathaway referred to his recent trip to India, where he was sent by the State Department to head the United States delegation to the international conferences and exhibits at New Delhi (page 54).

At the conferences, which were opened with a flood control conference of the UN's Economic Commission for Asia and the Far East, and during stopovers in Thailand, Japan, the Philippines and Hawaii, where he met with ASCE and other professional groups, Mr. Hathaway had opportunity to see at first hand the new effort that is being made on a world scale to pool technical knowledge and specialized skills. Everywhere he met men who had either received their degrees in the States or had training in one of the government agencies, such as the Bureau of Public Roads or the Bureau of Reclamation. "All," he said, "were most anxious to continue their contacts with engineers in the States, and in particular with the ASCE in order that they might keep abreast of engineering advancements."

In Japan, where Mr. Hathaway addressed about 400 members of the Japanese Society of Civil Engineers, he found engineers "were primarily interested in learning the reasons for the rapid growth of ASCE, the relation of the engineering profession to the contracting and construction industries, and the underlying reason for the rapid industrial development in the United States, as well as the almost complete mechanization of labor, our great highway systems, and enormous construction projects, principally in connection with the development and utilization of our river systems."

Daniel W. Mead Prize Presented

The group was welcomed to Texas by Raymond F. Dawson, president of the Texas Section, and a representative of the mayor of Houston. Other features of the Wednesday morning business meeting included presentation of the Daniel W. Mead Prize for Juniors to Roy G. Cappel, Jun. M. ASCE, of New Orleans, and a general business session of the Society.

Defense Plan for Port of Houston Described

A disaster plan for the defense of the Port of Houston in case of atomic bomb attack or other emergency was described by Gen. W. F. Heavey, director of the port, in the principal talk at the Wednesday membership luncheon. Worked out by port officials in cooperation with the major industrial and terminal installations along the upper Houston Ship Channel, the Port Disaster Plan is so comprehensive it might well be copied by other port authorities.

"In our planning," said General Heavey, "we felt that every single citizen, within a radius of 50 miles or more from the center of a possible blast or other disaster, must have a definite job to do. The dozens of local, county, state, municipal and private agencies must work together in a coordinated, preconceived manner to accomplish all this in the earliest possible time, with a minimum duplication of effort, a maximum saving of lives and equipment and property . . . .

"All municipalities in the Houston Ship Channel area would coordinate the disaster activities of police agencies, fire departments, and public works agencies. The Red Cross, the Harris County Emergency Corps, and the County Medical Society would coordinate their plans and activities. The utilities companies, the heavy industries, and the various channel-front plants will have coordinated their own fire and security forces with those of the cities, state and county, and plant wardens have already been appointed in all such plants."

The Port Disaster Plan also includes provision for filtering radioactive waters

ASCE PRESIDENT Gail A. Hathaway presents traditional gavel to Ernest E. Howard, who recently retired as President, at Wednesday morning meeting. Upper view shows (left to right) Mrs. Hathaway with Mrs. Garner Endress and Mrs. Raymond Dawson, who have been active in formation of successful Texas Section Wives Clubs.

with a compound of lime and iron and for obtaining under-water cutting equipment to clear channels blocked by sunken ships. Deploring such defensive measures as bomb shelters, which he termed futile, General Heavey advocated the more basic security of an effective radar screen "with such fast and efficient fighters that no enemy bombers will ever get through to reach our vital ports."

Twelve Technical Divisions Meet

Under the general chairmanship of Mason G. Lockwood, twelve of the fourteen ASCE Technical Divisions sponsored one or more sessions. Of special interest were the papers describing the design and construction of such local projects as the Baytown Vehicular Tunnel, the Houston Ship Channel, Belton Dam and Reservoir, Falcon Dam, and Houston's spectacular new expressway system. Inspection trips to some of these projects supplemented the Technical Division sessions. Articles based on a number of the meeting papers are printed in this issue

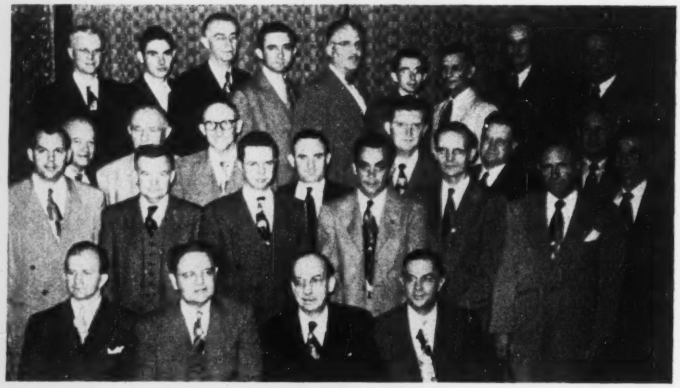
Local Section Delegates Meet

Representatives from a dozen ASCE Local Sections in the Southwest exchanged information and "known-how" at a two-day conference preceding the Convention. In opening the conference, Chairman Perley A. Rice said that its objective was the strengthening of the Local Section program and the expansion of activities by and for civil engineers in their own communities.

A program of prepared talks and forum-type discussions generated new ideas in the fields of operating Sub-Sections, District Councils, and Wives Clubs; Section publications, programs, and utilization of funds; and the relationship of engineers to their communities, of Sections to other organizations, and of ASCE to other engineering societies. Attention was given to the use by Sections of information from the Society's Washington office and to the integration of Juniors in Section activities. Reports on the development of civil defense programs indicated extensive Section participation in such programs.

Student Chapter Conference Held

The continuing energy of the Student Chapters was clearly demonstrated by the student representation at a conference the day before the opening of the Convention. A number of students from Southwestern colleges conducted open forums on Chapter affairs. The lengthy agenda included constructive discussion of such subjects as conduct of programs, field trips, financing, contacts with employers, and the development of a "professional consciousness" among Chapter members. The extensive program and student excursions were arranged by a Texas committee headed by Oscar Koch of Dallas.



CONFERRING AT ONE OF BREAKFASTS for authors and speakers at Houston Convention are, left to right, Prof. Philip C. Rutledge, chairman of executive committee of Soil Mechanics and Foundations Division; Mason G. Lockwood, chairman of technical program; ASCE Vice-President Fred C. Scobey, Berkeley, Calif.; and W. E. Blomgren, member of executive committee of Irrigation Division. Top photo shows some of delegates gathered for two-day Local Section Conference. In front row (left to right) are Charles W. Yoder, Milwaukee, Wis.; Raymond F. Dawson, president of Texas Section; Perley A. Rice, Richmond, Va., chairman of Committee on Local Sections; and Prof. John Focht, Austin, Tex.

Winners in the Regional Student Conference Contest were: James D. Tidewell, of Texas A. & M. College and secretary of the Student Chapter Conference, first prize; Robert B. Stevenson, of the University of New Mexico, second prize; and Finley Van Brocklin, of Mississippi State College, third prize.

Varied Social Program

An enjoyable social program, covering such diverse functions as a cocktail party and buffet dinner at the nationally known Shamrock Hotel and a barbecue and entertainment at the huge new Rice Stadium, gave the Convention visitors a glimpse of celebrated Texas hospitality. Following a custom instituted at the Los Angeles Meeting last spring, a series of authors' breakfasts constituted briefing sessions for all speakers and discussers. A feature of the ladies' entertainment, headed by Mrs. Robert J. Cummins, was the daily morning coffee hour and reception. Robert J. Cummins was general meeting chairman.

Publicity Committee Active

An effective job of publicizing the Convention and the accomplishments of the profession was done by a local committee under the chairmanship of Howard T. Tellepsen. In addition to Mr. Hathaway's talk at the Rotary luncheon, other ASCE officers addressed local groups and appeared on radio programs focusing attention on the profession throughout the Convention week.

Actions of Board of Direction at Houston Noted

Some of the important actions taken by the Board of Direction at its Houston Meeting, February 19 and 20, 1951, are summarized here.

Engineering Manpower Commission

Continued active participation by ASCE on the Engineering Manpower Commission of EJC was assured by action taken by the Board. The action commits the Society to engage in a carefully programmed and extensive effort aimed at increasing the number of engineering graduates and of affording better utilization of engineers both in industry and military establishments.

Technical Procedure Committee Conference

Increased attendance by representatives of the Executive Committees of the Technical Divisions at the annual Technical Procedure Committee Conference next September was provided for by increased appropriation. Both the incoming and outgoing chairmen of the Executive Committee of each Technical Division will be requested to attend the conference. The Division Activities Committee was assigned the task of study and report on possible changes in the make-up of the Executive Committees of the Technical Divisions and the terms of office of the members of those committees.

Memoirs

The Board agreed to resume publication of memoirs of deceased members in TRANSACTIONS on a reduced scale from the size of the memoirs formerly published.

ASCE Meeting at Miami

The Board accepted the invitation of the Miami Section to hold the June 1953 meeting of the Society at Miami, Fla.

Manual on Surveying Terms

Funds were provided to complete the manuscript for a new Manual on Definitions of Surveying Terms, which has been in preparation for several years under the chairmanship of C. E. Breed.

Proceedings-Separates

The heavy paper covers now being used with Proceedings-Separates were ordered discontinued by the Board.

President for 1952 Nominated

The Nominating Committee selected Carlton S. Proctor as the official nominee for President of the Society for 1952.

Student Chapters Authorized

The Board approved the establishment of Student Chapters at the University of Denver, the University of Hawaii, and Howard University.

Interim By-Laws

The Interim By-Laws now in effect, which were submitted to all Local Sections for review and suggestions, were approved with minor changes and revisions.

Increased Unity of Engineering Profession

The Board gave extended consideration to several documents and reports relating to the subject of Increased Unity of the Engineering Profession. The Executive Secretary was directed to send copies of these documents to the President and Secretary of each Local Section and Sub-Section for their information and study. Suggestions are to be invited from Local Sections and past officers.

Inactive List

The establishment of a military service inactive list for 1951 was confirmed by the Board.

Washington Office Is Active in National Affairs

Activities of the Washington office of ASCE during the calendar year 1950 were reported to the Board of Direction of the Society at its Houston meeting by Joseph H. Ehlers, ASCE Field Representative. Since many matters pertaining to national affairs were handled by Engineers Joint Council with full participation by ASCE, they are mentioned as a part of the ASCE program. Excerpts from Mr. Ehlers report, which emphasizes the developments of the last quarter, are reported here.

There were three legislative objectives: (1) To amend the Army Organization bill in respect to protecting the status of engineers; (2) to enact the National Science Foundation bill and the corresponding appropriation bill; and (3) to enact the D. C. Engineers Registration bill. All these stated objectives were successfully and completely accomplished after many near-upsets. The first two of these objectives were handled by EJC panels under the able leadership of the ASCE member who served as chairman.

In the case of the Army Organization bill, I attended all hearings and substituted for the chairman in brief testimony before the Senate Armed Services Committee. In connection, with the National Science Foundation, I attended all hearings, with Chairman Bakhmeteff presenting testimony. I kept in contact with the Bureau of the Budget in urging the appointment of EJC nominees to the Board. Three of the EJC nominees were placed, giving excellent representation for the profession. In the matter of the D. C. Engineers Registration bill, a written statement was presented to the Congressional Committee in support of the bill.

In respect to the Executive Department actions the principal objectives of the Washington office were: (1) Preparation of a Water Policy Report advisory to the President's Commission; (2) participation in policy making in the field of engineering manpower; and (3) establishment of an Advisory Committee on Engineering in the U. S. Civil Service Commission. These were primarily EJC objectives with strong ASCE participation.

Manpower is being handled by an EJC Manpower Commission, and policy statements have been transmitted to the government. With respect to Civil Service matters, I served as chairman of the EJC Committee on Engineers in Civil Service. The Civil Service Commission has appointed a high-level policy committee based on nominations by EJC.

Defense Mobilization Activities

During the past quarter the activities of the Washington office have shifted rapidly from normal peacetime interests to mobilization and emergency measures and agencies.

Principal interests have been centered in the National Production Authority following the passage of the Defense Production Act of 1951. Three divisions of direct interest have been established in NPA: Construction Materials, Construction Controls and New Facilities. The Washington office has been in touch with all these offices. These divisions have been placed in a Bureau of Facilities and Construction. I have conferred with the director offering the assistance of the Washington office. On a new Construction Advisory Committee to NPA, J. B. Converse, M. ASCE, represents the civil engineering field. This office has also been in touch with the Interior Department and other agencies concerning their construction controls interests.

Conferences have been held with ECA, the Housing Agency and several other agencies concerning methods of engaging professional engineering services and compensation for such services.

Joint Activities with Other Associations

Since the Society has such a small establishment at Washington, joint activities with other groups are very important. They enable us to cooperate with organizations undertaking extensive and expensive programs in Washington.

EJC is the most important of such cooperative efforts. The facilities of this office have been placed at the disposal of EJC committees dealing with national affairs. I have attended the regular bimonthly meetings. As a member of the National Engineers Committee of EJC, I have had contact with newly appointed government officials and discussed the relationship of their agencies to the engineering profession.

The ASCE-AGC Joint Committee covering the engineering-contracting field is of great importance. Some problems relating to the new controls can be dealt with jointly. AGC has an exceptionally comprehensive organization in Washington with specialists and experts in various construction fields as members of its staff. An important meeting attended by prominent officials of both groups was held in December to discuss several apsects of the defense program.

The Joint Committee of the Design Professions brings together the architects, civil and mechanical engineers, city planners and landscape architects. The executive committee of this group has drafted statements concerning the proper division of responsibilities on joint enterprises for various types of work.

The Construction Industry Advisory Committee, sponsored by the U. S. Chamber of Commerce and under the chairmanship of Carlton Proctor, M. ASCE, brings together the broadest cross section of construction industry groups, including materials manufacturers and financing agencies. This group has played an important part in dealing with problems concerning materials and construction controls under NPA. Problems are fully discussed by the staff executives of the groups involved, in advance of the general meetings.

Last and perhaps most important from the staff viewpoint is the Public Works Advisory Committee. This was previously an advisory committee to FWA and then to GSA. With the splitting up of GSA's construction functions, the committee is working as a Public Works Advisory Committee available to all agencies and to serve as a contact point for staff executives of the principal groups in Washington. I am serving as a member of a subcommittee on the revision of Government Construction Contract Form 23 and of a subcommittee on professional services contracts. Our proposed revised government contract form has been submitted to the government.

Contracts and fees for engineering and architectural services as handled by several agencies are receiving careful consideration.

President Hathaway Heads U.S. Delegation to International Engineering Conferences

The impact of Western technological progress on the East was graphically demonstrated in the series of international engineering conferences and exhibitions recently concluded in New Delhi and Bombay, India. Members of the United States delegation, which was headed by ASCE President Gail Hathaway and included a number of Society members, were particularly impressed by the Indian International Engineering Exposition, the first of its kind ever held in the East.

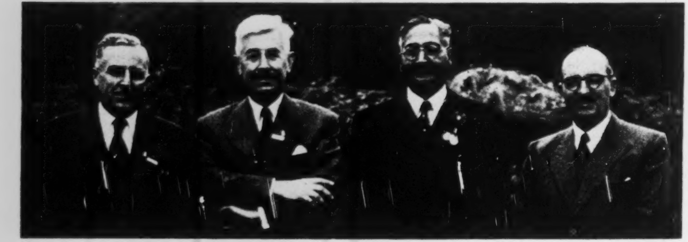
Occupying about 35 acres between Delhi and New Delhi, the exhibition was arranged to give the average Indian an idea of the technical marvels of the Western world and of native engineering projects, particularly in the field of water and power development, aimed at achieving a higher standard of living for the country. In addition to the industrial displays of 20 foreign countries including the United States, many impressive exhibits had been arranged by the states and industrial concerns of India.

About 800 engineers from 38 countries attended the New Delhi conferences—the meetings of the World Power Conference, the International Commission on Large Dams, and the International Commission on Irrigation and Canals. More than 200 technical papers were submitted to the various conferences. A flood control conference of the UN's Economic Commission for Asia and the Far East, which opened the proceedings, emphasized the international character of the program.

The Conference on Large Dams, the fourth to be held in the past 17 years, was the largest and most productive of the New Delhi meetings. Of the 111 papers submitted, 16 were contributed by Americans. Members of the State Department delegation to this conference included ASCE President Gail Hathaway, chairman; ASCE Director Waldo Bowman, who supplied material from which this release was prepared; Director Francis S. Friel; and ASCE Members L. F. Harza, C. E. Blee, J. H. Douma, P. T. Bennett, W. C. Cassidy, L. E. Rydell, L. N. McClellan, and F. L. Adams.

Preceding the New Delhi Conferences, the International Association for Hydraulic Research held a four-day session in Bombay. In an address to the 250 delegates representing 27 countries, President Lorenz G. Straub, M. ASCE, director of the St. Anthony Falls Hydraulic Laboratory at the University of Minnesota, hailed the congress for its contributions to engineering knowledge and research on a world scale.

Visitors to the conferences and expositions have high praise for A. N. Khosla, M. ASCE, chairman of the Indian arrangements committee, and N. D. Gulhati, chairman of the entertainment committee, and their helpers for their efforts to bring about a better understanding of India on the part of their foreign guests.



TOP MEN AT NEW DELHI CONFERENCE ARE, left to right, ASCE President Gail A. Hathaway, chairman of United States delegation; Andre Coyne (France), president, International Commission on Large Dams; A. N. Khosla, president, International Commission on Irrigation and Canals; and Vincent de Ferranti (Great Britain), chairman, World Power Conference.

FROM THE NATION'S CAPITAL

JOSEPH H. EHLERS, M. ASCE **Field Representative ASCE**

The organizational pattern of economic controls has been relatively stable during the past month. The most important change concerned the appointment of former Civil Service Commissioner Arthur Flemming to head the manpower committee for Defense Mobilizer Wilson. The recent de-emphasizing of the National Security Resources Board was illustrated in a redelegating of functions. The Defense Production Authority rather than NSRB will henceforth issue the accelerated tax-amortization certificates on new plant facilities. Certificates authorizing loans for plant expansion will be issued by DPA instead of the various departments which previously issued them.

The decline in prestige of RFC from its once lofty place and the adverse comment on it by a congressional committee point to a weak spot in the mobilization organization. A trusted fiscal agency to conduct impartial businesslike operations in connection with materials and new facilities expansion is an absolute necessity for a smooth-working defense program.

Licensing of Commercial Building

The new Federal Reserve Board requirements of a 50 percent down payment and 25 years amortization will have a restrictive effect on new commercial building construction.

In connection with the licensing of commercial building and the handling of hardship cases under NPA Order M-4, applications for license may be obtained at any of the many Department of Commerce local offices. When filled out, however, they should be returned only to the appropriate regional offices serving Commerce and NPA in 13 cities or to one of five District Offices (Baltimore, Detroit, St. Louis, Los Angeles and Portland, Ore.) and for the District of Columbia, to the Construction Controls Division of NPA in Washington. Construction of plants for printing newspapers, books and magazines, as well as radio and television studios are in general exempt from the licensing order.

Obviously a program such as this licensing system which would prohibit the use of a few hundred tons of steel in a building but permit unimpeded start of a 10,000-ton steel bridge is not a complete program.

Controlled Materials Plan

A controlled materials plan will be needed during the year to provide proper distribution of steel, copper and aluminum. Such a plan requires careful estimates of needs by all claimant groups and then whittling down of the allotments to each producer to reduce the total to the available supply. A staff group has been at work developing details of the plan. When the D.O. priority system is stretched to the breaking point, it will be put into effect.

Although D.O. ratings by defense agencies constitute the official priority system, actually special "directives" for aiding new plant construction and for other special urgent purposes are increasing in number and result in priorities paralleling the D.O. rating system.

Priorities will probably soon be given for maintenance and repair on industrial buildings. Another demand for priorities comes from agencies handling power and transportation.

If actual defense spending is pushed up to $4 billion per month during the next twelve months, as is hoped for, it would account for one-sixth of the gross national product now approaching 300 billions.

Even with the great decline in residential building an expected large increase in industrial construction will result in greater use of steel for construction this year. Industrial construction is estimated to take about three times as much steel per dollar of construction as does housing.

Aluminum Production Order

A prohibition order eliminating the use of aluminum from a long list of products becomes effective April 1 (NPA Order M-7 as amended February 1). A similar order on copper is already in effect (Order M-12, see CIVIL ENGINEERING for February, page 51).

ASCE MEMBERSHIP AS OF FEBRUARY 9, 1951

Members	7,789
Associate Members	10,041
Junior Members	13,777
Affiliates	68
Honorary Members	39
Fellows	1
Total	31,715
(February 9, 1950	28,105)

A 50 percent increase in aluminum and 20 percent in steel capacity is hoped for. This should result in an abundance of these two metals two years hence, although the outlook for copper is much darker. Much new production will in fact be available after the defense activity ceases.

Congressional Legislation

The Contract Renegotiation Bill (H.R. 1724) which passed the House has had numerous amendments added in the Senate Finance Committee.

A Joint Resolution (H.J.Res. 4) proposes approval of the agreement on the St. Lawrence Waterway project following urging by the President.

An incidental aspect of the Defense Housing Bill (S. 349 and H.R. 1272) of particular interest to civil engineers is the inclusion of public works construction in the Housing and Home Finance Agency activities. The first encroachment of this agency into the public works and heavy engineering field was in connection with Reorganization Plan No. 17 dealing with certain advance planning activities then being carried on by the General Services Administration. This minor program, a declining activity, was transferred to the Housing Agency. The new proposal puts the Housing Agency in charge of the building of these public works projects, particularly in respect to the approval of the projects for grants and loans, a function similar to the Lanham Act activities of the former Federal Works Agency.

The attention of the Washington office has been called to the fact that Army proposals for negotiating engineer-architect design contracts on the basis of estimated costs plus 10 percent as the lump sum contract figure have recently compelled firms to decline some work on the ground they might take a loss at the proposed figure. The Armed Services Procurement Act of 1947 sets a 10 percent profit limit for cost-plus-a-fixed-fee contracts, but does not require negotiating lump sum contracts on this basis.

The Federal Civil Defense Administrator has urged that each state and territory have a recruitment program for civil defense volunteers in full operation by April 1. He also has urged passage of necessary state legislation with adequate appropriations, appointment of a full-time director, and establishment of an operating agency in every community.

Washington, D.C.
February 14, 1951

ASCE Group Is Formed by Members in Athens

From far-off Greece comes word of the formation of an Athens Chapter of ASCE members living there. At the dinner meeting of organization, speakers stressed the need for continuing technological cooperation between Greek and United States engineers and affirmed the value of such professional groups as the newly formed Athens Chapter. A. Kalinsky, director of construction for the Ministry of Agriculture, was elected president, and T. N. Michalopoulos, designing engineer, Greek Sanitation & Hydraulic Works Construction Co., secretary.

TO FACILITATE TECHNOLOGICAL AND PROFESSIONAL COOPERATION between Greece and United States, 30 members of Society resident in Greece and their guests meet at dinner to organize Athens ASCE Chapter.

Louis C. Sabin, Honorary Member of ASCE, Dies

Louis C. Sabin, Honorary Member of ASCE and authority on Great Lakes and allied engineering projects, died at his home in Cleveland, Ohio, on December 30, at the age of 83. He was noted particularly for his development of the multiple wire method of base measurement for the Lake Survey, and for studies of the regulation of the height of water in Lake Erie and the effect on lake levels of power projects.

LOUIS C. SABIN, Hon. M. ASCE

As general superintendent of the St. Mary Falls Canal at Sault Ste. Marie, Mr. Sabin designed and constructed what are still its largest locks—Davis Lock and Fourth Lock—to meet the load imposed on the waterway by World War I. Fourth Lock was named Sabin Lock in his honor by Congress in 1943, when World War II demonstrated how well he had anticipated the demands on the canal, one of the world's busiest waterways. From 1925 until his retirement in 1948, Mr. Sabin was vice-president of the Lake Carriers Association, with headquarters in Cleveland.

A graduate of the University of Michigan, Mr. Sabin later received the honorary master of engineering degree there. He became a member of ASCE in 1902, and was elected Honorary Member in 1944. His other affiliations included Tau Beta Pi, the American Association for Testing Materials, the International Association of Navigation Congresses, and the Cleveland Engineering Society.

Mahaffey Memorial Fund to Give Student Aid

In memory of Sterry Mahaffey, who at his death on July 1, 1950, was president of the Virginia Section of ASCE and engineer director of the Virginia Road Builders Association, the latter organization has established a Student Aid Fund of $100 a year in each of the three colleges in the state financed in part by public funds—Virginia Military Institute, Virginia Polytechnic Institute, and the University of Virginia. To be disbursed through the ASCE Student Chapters in each of the schools, the funds have the primary objective of attracting young men into the highway engineering field. They are currently being used by the Chapters as expense grants and prize awards for papers.

Organized in 1943 in the interest of better highways for the state, the Virginia Road Builders Association now represents approximately 95 percent of the firms engaged in the construction of Virginia highways.

Washington Award Goes to Electrical Engineer

Edwin H. Armstrong, an electrical engineer and professor of electrical engineering at Columbia University, is winner of the 1951 Washington Award. A pioneer in the field of radio, Professor Armstrong is cited "for outstanding inventions basic to radio transmission and reception and notable service to his country."

The Washington Award, a joint award of the Four Founder Societies and the Western Society of Engineers, is given annually for "accomplishments which preeminently promote the happiness, comfort and well being of humanity." Presentation of the award to Professor Armstrong was made at a joint dinner meeting of the participating societies at the Furniture Club of America on February 19.

Robert Cypher Joins C.E. Advertising Staff

Robert S. Cypher

Robert S. Cypher, former salesman for Dun & Bradstreet, New York City mercantile accrediting firm, has joined the advertising staff of CIVIL ENGINEERING as Eastern representative. A veteran of World War II, Mr. Cypher served as a non-commissioned officer in the 27th Infantry Division for five years—for more than three years in the Pacific Theater. Upon his release from the Army, he completed his education at Pace College, a New York City school of marketing, advertising, and selling.

Coming Local Section Events

Central Ohio—Meeting in the Chittenden Hotel, Columbus, March 15, 6:15 p.m.

Florida—Meeting at the Seminole Hotel, Jacksonville, March 13, at 7 p.m.

Illinois—Weekly luncheons every Friday at the Chicago Engineers Club, at 12 noon.

Intermountain—Meeting in Salt Lake City on March 16.

Kansas—Meeting in Topeka, March 16, at 6:30 p.m.

Los Angeles—Dinner meeting at the Alexandria Hotel, Los Angeles, March 14, at 8 p.m., preceded by dinner at 6 p.m.

Maryland—Meeting at the Engineers Club of Baltimore, Baltimore, March 14, at 8 p.m., preceded by dinner at 6 p.m.

Metropolitan—Meeting in the Engineering Societies Building, New York City, March 21.

Miami—Meeting in Miami the first Thursday of each month.

Northwestern—Meeting at the Coffman Memorial Union, University of Minnesota, the first Monday of each month.

Oklahoma—Dinner meeting of the Oklahoma City Branch in the Y.W.C.A. Building, Oklahoma City, March 16, at 6:30 p.m. Meeting of the Tulsa Branch in the Chamber of Commerce Building, Tulsa, the first Monday of each month.

Philadelphia—Meeting at the Engineers Club, Philadelphia, on March 13. Meeting of Delaware Sub-Section on March 20.

Syracuse—Meeting in Syracuse, March 22.

Tacoma—Meeting in Tacoma on March 13.

Tennessee Valley—Dinner meeting of the Knoxville Sub-Section at the S & W Cafeteria, Knoxville, March 14, at 6:15 p.m. Dinner meeting of Oak Ridge Sub-Section at the Ridge Recreation Hall, Oak Ridge, March 14, at 7:30 p.m.

Texas—Luncheon meeting of the Dallas Branch the first Monday of each month, at the Hotel Adolphus, at 12:15 p.m. Luncheon meetings of Fort Worth Branch the second Monday of each month at the Blackstone Hotel, at 12:15 p.m.

Scheduled ASCE Conventions

SUMMER CONVENTION
Louisville, Ky., June 13–15
(Board of Direction meets
June 11–12)

ANNUAL CONVENTION
New York, N.Y., October 22–25

SPRING CONVENTION
New Orleans, La., March 5–7,
1952

News of Local Sections Briefed

SECTION	DATE	ATTENDANCE	PROGRAM
Buffalo	Jan. 16	36	Luncheon meeting. An illustrated talk on construction of first section of Toronto subway was presented by Charles B. Molineaux, chief engineer, Arthur A. Johnson Corp., and general manager, Pitts, Johnson, Drake & Perini, joint venture contractors.
Central Illinois	Jan. 11	. . .	Ladies Night meeting. Prof. Harold R. Wanless, of University of Illinois, spoke on "Geological Phenomena."
Colorado	Jan. 8	69	Dinner meeting with Charles Hunt, of U.S.G.S., outlining the geological history of Denver, and William Judd, describing the subsoil conditions of the area.
Dayton	Jan.	26	M. W. Tatlock, partner in Ralph L. Woolpert Co., Dayton, Ohio, discussed the Van Buren Township water supply. He was recently elected to a three-year term on District 9 Council.
Georgia	Jan. 5	. . .	Luncheon meeting with S. R. Young, head of Atlanta & West Point Railroad, Atlanta, Ga., speaking on railroad problems.
Illinois	Dec. 15	75	Annual meeting with election of A. L. R. Sanders, as president; Howard F. Peckworth, first vice-president; Frank W. Edwards, second vice-president; and Henry Miller, treasurer. H. F. Sommerschield was elected secretary for a two-year term.
	Jan. 17		Junior dinner meeting. Jim Zimmerman and E. W. Meisenhelder III were principal speakers.
Intermountain	Jan. 18	30	Solar engineering was discussed by Richard N. Thomas, associate professor of mathematics and astronomy, University of Utah.
	Jan. 20	22	L. G. Haskell, maintenance engineer, Salt Lake Pipe Line Co., spoke on oil-line transportation.
Ithaca	Jan. 30	. . .	Dinner meeting featuring George McAlpin, director of soil mechanics, New York State Department of Public Works, as speaker.
Maine	Jan. 20	23	Annual business meeting with election of following officers: Neal D. McDowell, president; Stephen C. Knight, Jr., vice-president; Vaughan M. Daggett, secretary; and Huge D. Chase, treasurer.
Maryland	Jan. 10	117	Dinner meeting. The effects of turnpikes on metropolitan areas were outlined by Farley Gannett, president Gannett, Fleming, Corddry & Carpenter, Inc., of Harrisburg, Pa.
North Carolina	Jan. 13	82	Annual business meeting. Newly elected officers include J. Norman Pease, president; Carroll L. Mann, Jr., senior vice-president; and P. D. Davis, junior vice-president. Presentation of student awards and Life Membership Certificates. ASCE Vice-President William R. Glidden stressed the need for continued study by engineers throughout their careers.
Oklahoma **Tulsa Branch**	Jan. 8	. . .	Role of engineer in defense effort was outlined by L. L. Dresser, president National Society of Professional Engineers.
Panama	Jan. 22	85	Symposium on construction of Panama Hotel. Participants included Messrs. Victor J. Fabrega, Guillermo Rodriguez, and Paul Kowalchik, engineers on project. Tour of project followed.
Pittsburgh	Jan. 9	35	Juniors meeting. J. E. O'Leary, vice-president in charge of sales, Pittsburgh Des Moines Steel Co., was guest speaker.
	Jan. 12	35	Joint meeting with Civil Section of Engineers' Society of Western Pennsylvania featuring G. H. Carpenter, as principal speaker.
	Jan. 25	80	Annual meeting with addresses by Vice-President William R. Glidden and ASCE Director Paul Holland.
Puerto Rico	Jan. 19	. . .	Dr. Karl Terzaghi, professor of civil engineering, Harvard University, was principal speaker.
Toledo	Dec. 13	40	Dinner meeting. Newly elected officers include President C. A. Shaler, First Vice-President J. C. Webber, Second Vice-President R. C. Hansen, and Secretary-Treasurer C. H. Kurtz.

NEWS BRIEFS . . .

Use of Prestressing in Freeway Building Advocated at ACI Annual Convention

Prestressed slab construction offers special advantages for urban expressways and freeway separations where shallow depths are required, Stewart Mitchell, M. ASCE, bridge engineer for the California Division of Highways, told members of the American Concrete Institute at their 47th annual convention in San Francisco, February 20–22. Although, with present labor costs, prestressed construction offers little saving over ordinary types of construction, when costs are reduced it will compete with conventional construction, he predicted.

Considerable savings would be possible in depressed freeways and grade separations, Mr. Mitchell believes, because of reduced cost of the bridge superstructure and reduced excavation. Since prestressing allows less depth of beam, the reduced depth of over-passes would save considerable excavation and also permit savings in cost of abutments, retaining walls, and other features.

F. N. Hveem, construction engineer for the California Division of Highways, discussed the prevention of joint troubles in concrete pavements at the same session. He reported that warping and curling of the slabs was a major factor contributing to pumping and faulting of the joints. A suggested remedy was the elimination of expansion joints and placing contraction joints as far apart as possible.

Harry F. Thomson

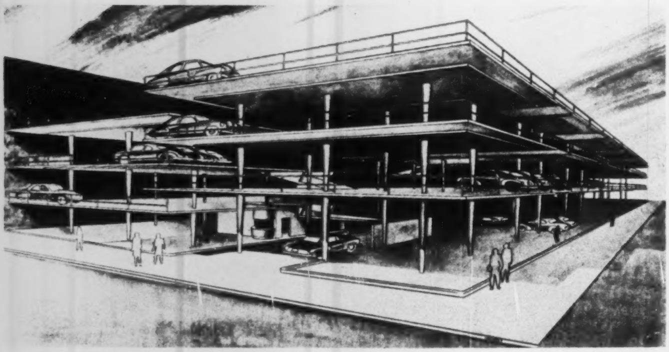
Precast concrete was said to afford excellent protection against atomic blast by Arsham Amirikian, M. ASCE, head designing engineer for the Navy Bureau of Yards and Docks, Washington, D.C., in another leading talk. Precasting, he asserted, is suitable for the construction of emergency shelters and protective structures and can also be used to advantage in providing existing structures with a protective shell. The readily assembled framing elements could be prefabricated at regional plants and stockpiled at various points for immediate use in an emergency, he stated.

Other ACI sessions dealt with the use of reinforced concrete in earthquake-resistant structures; correction of false set in cement during the manufacturing process; and use of new materials to cut construction costs.

An important result of the convention was approval of revisions of the ACI Building Code, which will now go to all members for ratification. The changes in the code allow for the improved properties of new-style deformed reinforcing bars, resulting in steel savings in reinforced concrete construction. The code is discussed elsewhere in this issue in a paper by C. A. Willson, M. ASCE.

Former ASCE Director Harry F. Thomson, manager of the Redi-Mix Concrete Division of the Materials Service Corp., Chicago, was elected president of the organization for the coming year. Mr. Thomson also received the Wason Medal for "the most meritorious paper" of the year. Other ASCE members receiving awards included Charles S. Whitney, Milwaukee, Wis., winner of the Alfred E. Lindau Award, and W. S. Colby, of Boston, Mass., the Construction Practice Award.

Harmer E. Davis, Assoc. M. ASCE, director of the Institute of Transportation and Traffic Engineering at the University of California, was general chairman.


USE OF UNIT BUILDINGS AND FLAT-SLAB CONSTRUCTION in a New Orleans parking garage was described at the recent ACI convention by L. G. Farrant, Assoc. M. ASCE, and W. C. Harry, consulting engineers of Miami, Fla. Ideal balance between function, economy, and aesthetic values was achieved, they asserted.

Engineers Receive Moles' Awards at Annual Dinner

The satisfactions, tangible and intangible, of a career in the construction industry were stressed by both winners of the The Moles' eleventh annual awards "for outstanding contributions to construction progress" at the organization's annual award dinner, which was held in New York on January 31.

Member award winner was Ray N. Spooner, M. ASCE, treasurer of Allen N. Spooner & Sons, Inc., dock-building firm with a notable record in the construction of New York Harbor installations. He was cited for "his superlative and effective service and his eminent accomplishments, notably in the fields of waterfront, pier, and harbor construction." The non-member award went to Lester S. Corey, president of the Utah Construction Co., San Francisco. Cited for his "high excellence as a leader and his conspicuous skill, notably in the fields of dams, irrigation, and railroad construction," Mr. Corey was director of the Columbia Construction Co., builder of Grand Coulee Dam.

Honorary membership in the organization, New York association of heavy construction men, was presented to former Postmaster General James A. Farley, for many years president of the General Builders Supply Corp., of New York. Moles' President James F. Salmon presided at the dinner, which was attended by 1,200.

Steel Companies to Spend $1.2 Billion for Expansion

About $1.2 billion dollars will be spent for expansion and improvement of the steel industry in 1951, according to an announcement from the American Iron and Steel Institute. This record outlay will be 134 percent higher than the $513,000,000 spent last year and 307 percent above the 1941 expenditures. About 35 to 40 of the 115 iron and steel companies reporting are engaged in increasing their iron and steelmaking capacities. By the end of 1952, steelmaking furnaces will be able to make more than 117,500,000 tons annually at full production, compared with 104,229,650 tons a year at present.

United Nations to Expand Technical Aid Program

A greatly expanded program of technical assistance to the less developed areas of the world is reported by the United Nations. About $20,000,000 is available for 1950 and 1951, with most of it to be spent in 1951.

Operating in cooperation with similar programs undertaken by such intergovernmental agencies as the Point Four administration, the present program has initiated work in 17 countries on projects related to their economic development and projects in nine other countries of indirect economic benefit. Technical assistance missions have been sent to Afghanistan, Bolivia, Brazil, Burma, Colombia, Chile, Ecuador, Haiti, India, Indonesia, Pakistan, Iran, Thailand, Lebanon, and Mexico, and arrangements for similar missions are being made with other countries.

In addition, almost 1,000 training opportunities were made available in 1950 under a fellowship program that provides specialized training by experts to experts from recipient countries. Under these programs, officials study from three to six months in the host country and then return home to teach others the improved techniques they have learned.

Calling the program a prodigious effort to raise living standards, Hugh L. Keenleyside, director general of the UN Technical Assistance Administration, points out that, "Technical assistance for peoples who are reaching forward to grasp their aspirations can mean increased wealth for citizens of developed countries as well as those of less developed areas."

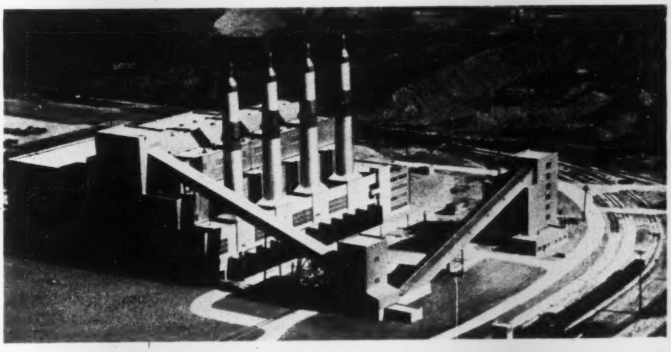
American Engineers to Advise on Greek Land Reclamation

A reclamation program designed to improve more than a million acres of crop lands in six river basins of Greece is outlined in a release from the Economic Cooperation Administration. The ECA also announced that the Knappen, Tippetts, Abbett Engineering Co. of New York, has signed a contract with the Greek Government for surveys, reclamation plans and designs for required structures.

Services and traveling expenses of the firm will be paid in dollars under the ECA's technical assistance program, while engineering costs in Greece will be assumed by the Greek Government. Leeds, Hill & Jewett, consulting engineers of Los Angeles, Calif., will be associated with the New York firm in carrying out the project.

Part of a coordinated program of technical assistance for land reclamation and development in Greece, the current project includes making plans for diversion dams on the Axios and Aliakmon rivers for irrigation of the Salonika Plain; plans for irrigation distribution systems in several areas; plans for the solution of a silting problem in the upper section of the Strymon River between the Greek-Bulgarian border and Kerkini Lake; and a development plan, including flood protection, drainage, irrigation, and general water use, for the Xanthi-Komotini Plain area in northern Greece.

New Ridgeland Station Increases Chicago Power Supply



RECENT DEDICATION OF RIDGELAND STATION of Commonwealth Edison Company of Chicago brings total plant capacity of system to 2,802,000 kw. Planned for ultimate capacity of 600,000 kw, plant represents part of company's postwar expansion program involving expenditure of more than $750,000,000. Preliminary work was started in August 1947, and first 150,000-kw unit is now in service. Second 150,000-kw unit will go into service in 1951, and third unit, already authorized, is scheduled for completion in 1953. Reflecting notable engineering and metallurgical advances made in past 25 years, new Ridgeland equipment operates with steam pressure of 1,800 psi and 1,050-deg temperature. About 1 lb of coal is required for production of each kilowatthour, in contrast to 1½ lb formerly required.

Elizabeth River Tunnel Section Is Launched

ONE OF SEVEN 300-FT-LONG SECTIONS of double-shelled steel casing, being used in construction of trench-type vehicular tunnel beneath Elizabeth River at Norfolk, Va., comes off shipways of Bethlehem-Sparrows Point Shipyard at Sparrows Point, Md. Launched January 17, section was towed 180 miles to tunnel site where, still afloat, it will be fitted with inner reinforcing ring of concrete and section of double-lane roadway 22 ft wide before being sunk into place in trench dredged across river bottom. Photo shows temporary "launching bow," which in launching is fitted to forward end of section to ease pressure against flat bulkhead as it hits water. Engineers on project are Parsons, Brinckerhoff, Hall & Macdonald, and contractors Merritt-Chapman & Scott Corp., both of New York.

Construction Activity in January Is 20 Percent Above January 1950

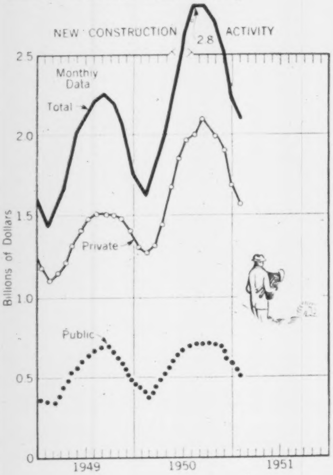
Construction activity in January was 20 percent higher than a year ago, despite a seasonal decline of 7 percent from the December 1950 total, according to a joint report of the Building Materials Division of the Department of Commerce and the U. S. Labor Department's Bureau of Labor Statistics. The total value of new construction put in place amounted to nearly \$2.1 billion.

A speeding-up of industrial plant expansion, particularly by the federal government, was beginning to be evident, the joint agencies note. Though military and naval construction was still at a relatively low level during the month, it was up to three times the January 1950 rate, and commercial building was 54 percent higher.

Privately financed construction put in place during the month was valued at more than \$1,500 million, 7 percent less than in December 1950 and 21 percent above a year ago. More than one-half of the total private outlay for new construction is attributed to new homebuilding, which continued at record levels for the season.

Public expenditures for new construction during January amounted to about \$500 million, 8 percent less than in December 1950. However, they were 22 percent above the level of January last year—primarily as a result of increased outlays for schools, highways, and military facilities.

THOUGH DEPARTMENT OF COMMERCE CURVES for January show slight seasonal decline from December, construction activity is 20 percent above January 1950 total. More than half of current activity is attributed to record homebuilding.



NSRB Manpower Advisory Committee Testifies to Senate Subcommittee

A comprehensive and detailed method of maintaining a limited supply of and for channeling scientists and engineers into the armed forces, industry and education, and into government research was recently presented to the Preparedness Subcommittee of the Senate's Armed Service Committee by Dr. Charles Allen Thomas of St. Louis. Dr. Thomas testified in behalf of the recently appointed Scientific Manpower Advisory Committee (February issue, page 58), of which he is chairman.

Based on the premise that American technological skill can offset numerical inferiority to potential enemies, the plan has the following goals:

1. To provide a method for maintaining a continuous supply of technically trained men.
2. To devise a plan for utilizing men with critical scientific skills to the greatest advantage.
3. To integrate the training of scientific manpower over a protracted period of emergency with the provisions of Universal Military Training.

To avoid an acute shortage of technically trained men in 1952 and 1953, the committee recommends deferment of all second- and third-year students now enrolled in colleges and universities. In addition, it recommends that in 1951 a total of 75,000 high school graduates and an equal number of present college freshmen be screened by competitive selection and deferred to continue their studies. This quota represents less than 10 per cent of the number of young men who reach age 18 each year.

In addition the plan proposes a continuing system which, under Universal Military Training, would assure an essential minimum of scientists and engineers in training at all times. To accomplish this, the committee recommends establishment of a Reserve Specialists Training Corps, similar to the ROTC, which would admit for scientific and engineering study approximately 75,000 youths each year.

Under Universal Military Service, all youths would serve for approximately 27 months. After four months of basic training, the plan would admit 75,000 competitively screened youths to scientific training in RSTC, deferring the 23-month balance of their military service until after graduation.

The plan specifically recommends that, when Universal Training is in full operation, 18-year-old youths (or 17-year-olds with their parents' consent) who are still in high school, should be deferred until graduation or age 19—whichever is sooner. This would make it possible for youths completing their military service to enter college if they choose, rather than being forced to lose further time by returning to high school.

Concurrently, the plan also provides for establishment of a National Scientific Personnel Board, which would at once begin to identify critical skills and classify men possessing them. The NSPB would examine all potentially valuable scientists and engineers referred to it by present Selective Service boards who would call attention to all men apparently possessing skills classified as critical. The Board would make recommendations to the President on the channeling of technical men into specialized scientific assignments in the military service, industry, teaching, or government research. With the graduation of RSTC men, the NSPB would recommend their assignments for the 23-month period of deferred military service. The placement function would assure the effective channeling of men into critical areas.

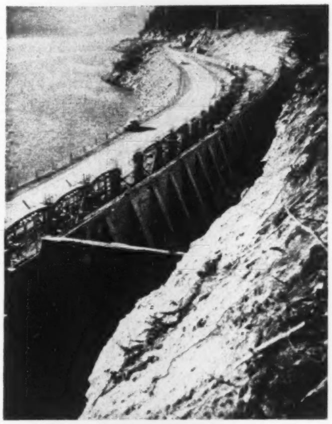
AGC Formulates Construction Plans for Civil Defense

Detailed recommendations as to how to plan for the most effective functioning of the construction contracting industry in clearing shattered areas and restoring essential facilities after a possible enemy attack have been sent to local organizations of the Associated General Contractors. Prepared at the request of the Civil Defense Administration, the recommendations represent more than a year of study of the problem by AGC officials in cooperation with civil defense authorities.

The basic recommendations made to the government are that construction organizations be used as units in clearance, demolition, emergency repair, and other tasks and that the industry, locally and nationally, be permitted to help plan its emergency operations as closely as possible along lines of normal civilian activities. Because general contractors are the normal coordinating and organizing force in the construction industry, the report recommends that AGC chapters or other local groups of contractors elect an outstanding general contractor for the construction industry representative on the engineering service of state and local civil defense organizations.

The AGC recommendations are expected to be considered by the CDA, which is preparing manuals for the guidance of state and local civil defense authorities in planning to utilize the facilities of the construction industry in the civil defense program.

Prefabricated Forms Aid Snowshed Construction



USE OF PREFABRICATED FORMS on construction of huge reinforced concrete snowshed for State of Washington on Highway 10 at Snoqualmie Pass permits completion of project before start of winter snows. Shown here is one of two sheds—500 and 1,300 ft long—built to protect right-of-way by permitting dangerous snowslides, which sometimes reach depth of over 20 ft, to pass harmlessly overhead. Reinforced concrete footing for main wall has standard cross section 19 ft wide and 4 ft at maximum thickness. Main (uphill) retaining wall is 1 ft 3 in. thick and 28 ft 3 in. high, with 2-ft-thick counterforts running at 10-ft 2-in. centers. Downhill side has 20-ft open bays running entire length of structures. Because of speed of assembly and number of reuses required, Uni-Form System for concrete forming was used. This system, which is manufactured by Universal Form Clamp Co., of Chicago, offers combined advantages of plywood face and steel frames. Project was designed and built by Washington State Highway Department.

Use of Steel Banned for New York State Thruway

Little or no structural steel will be available for construction of the New York State Thruway and most other public works after the middle of the year, according to Defense Mobilization Director Charles E. Wilson. The only exceptions will be hospitals and schools and defense housing, Mr. Wilson stated.

The government's program for conservation of steel to make more available for defense was outlined in a recent letter from Mr. Wilson to Gov. Thomas E. Dewey of New York. Though written in response to an inquiry from Governor Dewey for advice in formulating his state program, Mr. Wilson's letter sets forth policies applying to public construction throughout the country and likely to cause far-reaching changes in the public-works programs of states, municipalities, and other agencies.

While the extent and type of restrictive orders have not been developed in detail, Mr. Wilson wrote, "I must advise you that very little steel can be expected for new highway work other than access roads to new defense projects. Thus, throughways, parkways, and similar developments, even though helpful to civil defense, must wait. On the other hand, maintenance becomes of increasing importance, and every effort will be made to provide materials for this purpose.

"New building construction will also find it difficult to obtain steel. Here, too, every effort will be made to support the construction of schools and hospitals. In the case of schools, some attention would necessarily be given to their purpose, as for example, the construction of new engineering schools if there were substantial vacancies. Nevertheless, forward-looking educational and health programs must not be neglected."

In the field of public housing, priority must be given to defense housing projects and little, if any, steel will be available for other projects.

"It is our desire to develop the program with as few limitation orders as possible. However, new projects requiring large amounts of steel will drag on indefinitely unless they are needed as part of the defense program."

Straits of Mackinac Bridge Recommended

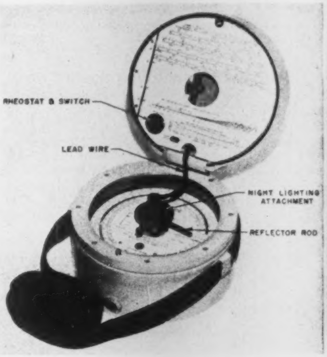
Construction of a bridge across the Straits of Mackinac is recommended as "both physically and economically feasible" by engineers for the Mackinac Bridge Authority in a preliminary report to the Governor of Michigan and the Michigan legislature. Estimated to cost $76,300,000 before financing, the structure is expected to pay for itself out of future revenues without increasing the fees now charged for ferry-crossing service and without direct state aid. Financing costs would be about $11,000,000, making the total cost $87,000,000.

The complete bridge structure would be 5 miles long, extending north from Mackinaw City to a point west of St. Ignace, where the present causeway juts out into the Straits. Of the suspension type, the proposed main span is 3,800 ft long, and the side span from the main piers to the anchorages have a length of 1,500 ft. The remainder of the crossing calls for a series of truss spans on concrete piers, varying in length from 160 to 560 ft. Huge cement blocks extending 140 ft below lake level would support the cable anchorage. The roadway would be four lanes wide, two in each direction with a low separator for safety. Minimum clearance at the center of the span is 150 ft, sufficient for the largest ships.

The present design includes provision for withstanding winds up to 120 mph and pressures from ice far in excess of those to which piers will ever be subjected. No problem is presented by the currents, which were found to have a maximum flow of less than 2 mph.

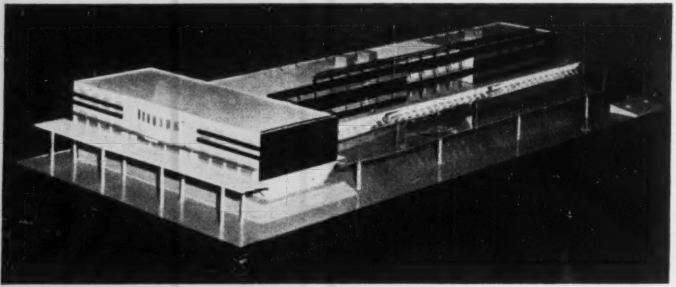
Consulting engineers to the Mackinac Bridge Authority are ASCE Members O. H. Ammann and D. B. Steinman, of New York City, and Glenn B. Woodruff, of San Francisco. Coverdale & Colpitts, New York traffic engineering firm, made a traffic survey for the Authority. Members of the Authority are Prentiss M. Brown, Chairman; Fred M. Zeder, M. ASCE, vice-chairman; William J. Cochran, Charles T. Fisher, Jr., George A. Osborn, Charles M. Ziegler, and Murray D. Van Wagoner, M. ASCE.

Army Develops New Surveying Altimeter



SURVEYING ALTIMETER, designed and tested by Army Engineer Research and Development Laboratories at Fort Belvoir, Va., measures elevations with accuracy of approximately 2 ft. An aneroid-type barometric leveling device, the instrument is intended for use up to 15,000 ft above sea level. Mechanism consists basically of single vacuum chamber, which expands and contracts in response to changes in atmospheric pressure. As chamber fluctuates, it actuates attached curved rack, pinion gear, and shaft, converting the movements of the chamber to rotation of the indicating hand. Equipped with electric illumination, altimeter can be used for day or night operation. The lid houses conversion and correction chart, rheostat and switch, sling psychrometer, lighting attachment when not in use, and two batteries that furnish energy for the $1\frac{1}{2}$-v lamp illuminating the scale.

Unusual Substructure Planned for North River Pier



FEATURED IN DESIGN OF NEW NORTH RIVER PIER 57 (shown here in artist's rendering) is pontoon-type substructure, consisting of three huge watertight boxes of reinforced concrete, whose buoyancy will support about 90 percent of total dead weight of pier. Construction will start soon, following recent award of $5,685,491 contract for substructure and deck to Merritt-Chapman & Scott Corp. and Corbetta Construction Co. The three hollow boxes will be constructed away from site, floated into exact position, and then sunk atop specially prepared gravel base built over piling of old pier. Two of boxes, each approximately 350 ft long by 82 ft wide and 34 ft deep, will support main length of pier, providing basement area for freight storage and handling. Elevators will connect basement and pier levels, but there will be no connections between the watertight boxes. The third box will be sunk broadside of others at shore end to serve as substructure for T-shaped bulkhead section of pier. Approximately 750 ft long and 150 ft wide, new pier will be constructed entirely of concrete and steel and will be completely fireproof. Project constitutes the largest single pier construction contract ever awarded by City of New York.

Ohio Sanitation Commission Initiates New Services

Examining a field largely unexplored, the Ohio River Valley Water Sanitation Commission will promote investigations to determine if unsuspected public-health hazards exist as a result of trace constituents from industrial and other wastes finding their way into streams. This action was taken at the recent quarterly meeting of the Commission, when an initial allotment of $13,500 was approved to enter into a contract with the Kettering Laboratory of Applied Physiology at Cincinnati. The laboratory will act in the role of consultant and conduct aspects of the study involving medical research.

"Faced as we are with the responsibility for establishing limits of waste discharge," said Henry Ward, chairman, "the Commission wants complete information about the possible injurious nature of water supplies containing minute quantities of certain wastes."

How the Commission program is geared to civil defense operation was revealed in a report from 16 water-quality monitoring stations established on the Ohio River and its principal tributaries. Primarily concerned at present with checking the source of taste-and-odor producing wastes originating from industrial pollution, the monitoring stations could adapt their operations for detection of substances resulting from enemy sabotage or atomic bombing. Co-operating with the Commission on this program are the U.S. Public Health Service laboratories in Cincinnati and private and municipal water-treatment plants.

Other actions taken by the Commission included a decision to explore thoroughly what effect, if any, the operations of the projected atomic energy plant at Paducah, Ky., may have on Ohio River water quality.

Coincident with the meeting, members of the Commission took part in ground-breaking ceremonies for Cincinnati's new sewage-treatment plant—the first major municipal plant to be built on the Ohio River since the Commission was established.

Corps of Engineers Awards Large Equipment Contract

Award of a $42,000,000 Corps of Engineers contract for equipment to the Caterpillar Tractor Co. is announced by Louis B. Neumiller, president of the company. The contract, which includes a National Production Authority DO rating containing priority assistance for scarce materials, calls for the larger-size standard tractors manufactured by Caterpillar, together with bulldozers, cable controls, and allied equipment.

Stating that the order will cut deeply into normally scheduled production, Mr. Neumiller predicted that by mid-year the company may be operating "under an Industrial Mobilization Plan calling for 62 percent of its production for the military forces and 38 percent for essential civilian uses." The plan, described as the first of its kind to be completed in the construction industry, has already been used by the military as a model in developing plans in other industries.

Highlights of 1950, Mr. Neumiller said, included the best safety record the company has ever had, peak employment, and the highest average annual employee earnings in the company's history.

AED Holds 32nd Annual Meeting in Chicago

The challenge posed to the construction equipment industry by the defense effort was the theme of the Associated Equipment Distributors' 32nd Annual Meeting, which was held in Chicago late in January with a record-breaking attendance of over 2,000. The five-day program included considerable discussion of the role of the distributor in a controlled economy and numerous distributor and manufacturer panels.

In a resolution, the association went on record as being "opposed to public construction by force account," and further recommended that "the contract method be employed on all construction by the federal government and all other governmental bodies." Another resolution urged Congress to practice "every possible economy in its domestic expenditures and to eliminate all unnecessary programs."

R. L. Arnold, of the Arnold Machinery Co., Inc., Salt Lake City, Utah, was elected president of the organization for the coming year. He succeeds C. F. Halladay, of Sioux Falls, S.Dak.

Arizona Fisheries to Use Colorado River Water

Non-consumptive use of Colorado River water by the State of Arizona fisheries station near Bullhead City, Ariz., will be permitted under the terms of a contract just signed by the Department of the Interior and the Arizona Game and Fish Commission, according to an announcement from E. A. Moritz, M. ASCE, regional director for the Bureau of Reclamation. Water pumped from the river just below Davis Dam, located 67 miles downstream from Hoover Dam, will flow through the raceways, rearing ponds, and hatcheries of the fishery and then return to the river. Following approval of plans and specifications by the Bureau, the Arizona Game and Fish Commission will install and construct all necessary pumping facilities, pipelines, and control structures required in the project.

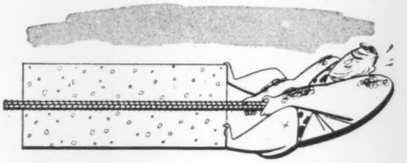
The hatchery will occupy some 38 acres of land in the Lake Mead recreational area under a special permit issued by the National Park Service, which administers the area.

Advantages offered by Inland HI•BOND since 1943 now officially recognized by American Concrete Institute

At the annual convention of the American Concrete Institute in 1949, Committee 208 on Bond Stress proposed changes in design stresses for concrete reinforcing bars. These proposals were made after Bureau of Standards tests proved that certain "improved" reinforcing bars could live up to higher standards.

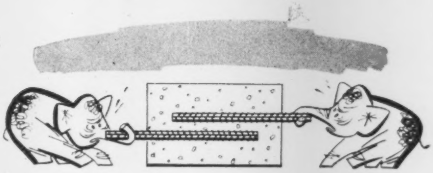
At the 1950 convention, the ACI Building Codes Committee adopted the proposals of Committee 208. And in February 1951, the Institute officially accepted the new building code change.

It is interesting to note that Inland HI-BOND has, for eight years, offered all advantages of higher bonding properties now officially recognized by ACI.



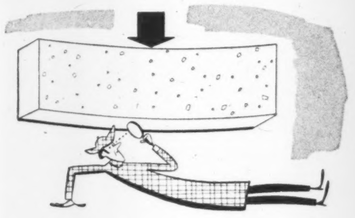
1 Increased bond stresses and greater resistance to slip

See reports on National Bureau of Standards research by Arthur Clark . . . ACI Proceedings, Vol. 43, p. 381; Vol. 44, p. 437; Vol. 46, p. 161; by C. C. Fishburn . . . ACI Proceedings, Vol. 44, p. 289.



2 Increased efficiency at splices

See reports on National Bureau of Standards research by Ralph W. Kulge and E. C. Tuma . . . ACI Proceedings, Vol. 42, p. 13.



3 Reduced width of tensile cracks

See reports on National Bureau of Standards research by David Watstein and Norman Seese, Jr. . . . ACI Proceedings, Vol. 41, p. 293.

4 Hook anchorages unnecessary in most applications

See reports on National Bureau of Standards research by C. C. Fishburn . . . ACI Proceedings, Vol. 44, p. 289; by F. E. Richart . . . ACI Proceedings, Vol. 45, pp. 97 and 237.

See new ACI Building Code

INLAND HI-BOND®

The reinforcing bar with the built-in anchorage

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Progress in Road Studies Outlined at Highway Research Board Meeting

To mark the completion of 30 years of study of problems involved in the design and construction of roads, the Highway Research Board held a special evening session during its recent annual meeting in Washington, D.C. Speakers for the occasion consisted of a group active in formation of the Board 30 years ago—former ASCE Director Roy W. Crum, who has been director of the Board since 1928; ASCE Honorary Member Thomas H. MacDonald, head of the Bureau of Public Roads; Hal H. Hale, M. ASCE, executive director of the American Association of State Highway Officials; and Detlev W. Bronk, president of the National Academy of Sciences. All stressed the importance of continuing basic research despite emergency restrictions. Mr. Crum was honored by the other speakers for his role in shaping the activities of the Board, with special reference to its current cooperative project in Maryland designated Road Test One.

A report of progress made on Road Test One, which has for its principal objective determination of the relative effects, on a selected section of concrete pavement, of the four different axle loadings on two vehicle types, was given during the four-day program. The report pointed out that, "To secure complete answers to the many questions involved in the interrelationships between loads, pavements, and subgrades, additional tests under other conditions will be necessary. None the less, it emphasizes, "many significant engineering facts are being derived from the test under one typical set of conditions."

The comprehensive coverage of practically all phases of highway economics, materials, design, construction, and traffic included a set of papers reporting detailed investigations of three state highway departments—California, Illinois, and New Jersey—with continuously reinforced pavements. Another symposium gave the findings of Kentucky, Minnesota, and Michigan in a ten-year study of concrete pavements.

Many of the meeting papers were abstracted in the December issue of *Highway Research Abstracts*, which is available from the Board, 2101 Constitution Avenue, Washington 25, D.C., at 30 cents a copy.

N. G. Neare's COLUMN

R. Robinson Rowe, M. ASCE

"This is canasta night," said Professor Neare, "so all jokers and deuces are wild."

"Including me," explained Joe Kerr. "What I want to know is whether you assigned this problem just to make me wild."

"Not at all. I just happened to hold a perfect bust the first time I played canasta and I wondered what my chance was of ever holding one again. I'll ask you nicely, can you tell?"

"Not exactly, but pretty close. First of all, you must have been playing four-handed or you would have held too many cards to not have a pair. So 11 were dealt you and you drew one, making 12. There are 108 cards in the deck, 12 of which are wild and 96 of which are 8 each of 12 kinds, trey to ace. You had 96/108 chance of drawing your first card, 88/107 for the second, and so on down to 8/97 for your 12th card. By my slipstick, the product of those 12 fractions is one chance in 41,000, which wouldn't worry me at all."

"I'm not worried, Joe, but isn't there a chance that there would be a red trey in your hand?"

"Oh, oh, I forgot that. I'd have to meld that and draw for a black trey. Now you've got me all confused."

"Let's start all over," interrupted Cal Klater. "Whenever you get a red trey, it really doesn't count as a draw, so we can ignore the existence of red treys entirely. For our problem we have a 104-card deck. If no two cards were alike, there would be ${}_{104}C_{12}$ different combinations of 12 cards. Now there are 4 ways of picking a black trey and 8 ways of picking each of the other cards, so the number of bust combinations is $4 \cdot 8^{11}$. The chance of getting a bust is the ratio of bust combinations to the number of all combinations, or

$$\frac{4 \cdot 8^{11}}{{}_{104}C_{12}} = \frac{2^{35} \cdot 12! \cdot 92!}{104!} = \frac{1}{50{,}309}$$

so Joe wasn't as far off as he was confused."

"That's right, Cal. Joe did pretty well. How well, you can judge from the range of answers I've seen here tonight, all the way from one chance in 5,782 to one in 350 trillion, not to mention those who say 'zero' because they don't play the game 4-handed, or at all.

"The really wild aspect of the game is the way wild cards get in opponents' hands instead of yours, a fact which players blame on sloppy shuffling of the big deck. Inventors have been quick to capitalize on this psychology, so the shuffling machine, or mixer-upper, has become a must. One of these has two platforms on which cuts of the deck are placed, so that the turn of a crank slips cards from the bottoms of the cuts into a single stack in the center well. For some reason it takes two cards from the right platform, then one from the left, and so on, so that two-thirds of the deck has to be set on the right side in order to make a fair shuffle. Now, if cuts are always made exactly 72 from the top to the right platform and 36 from the bottom of the deck to the left platform, after how many shuffles will the original order of the cards be restored?"

[*Many of the numerous Joe Kerrs said they hadn't heard of canasta. Stout fellows. Cal Katers were Flo Ridan (Charles G. Edson), A. Nuther Nutt, R. E. Philleo, and Marvin A. (Sauer Doe) Larson. Herman Finch's solution of the December problem was delayed by the Swutchburg flood.*]

Large Mill in Chile Starts Making Steel

The Huachipato Steel Mill, built by United States concerns in Chile, has just begun operation at the rate of 236,000 tons of steel ingots a year. The new plant, second largest in South America, has a potential annual capacity of 350,000 tons, which could be developed with relatively low investment to meet urgent defense needs. Pig iron from the plant has already been shipped to the United States, and steel is being exported to Uruguay, Argentina, Bolivia, and Peru.

Built at a cost of $87,425,000, the Huachipato plant was partly financed with $48,000,000 from the Export-Import Bank. The remaining capital came from United States copper and nitrate plants in Chile, the Corporacion de Fomento, and other enterprises.

Basic raw materials accessible to the plant, which is located near the extremely southern city of Concepcion, include iron ores from El Tofo mines to the north, and nearby deposits of limestone and coal. Operating 15 by-product plants, the Huachipato Mill has 4,500 employees, including 100 specialists from the United States. To facilitate its operations, it plans to build a modern town for 30,000.

Picatinny Arsenal Contract Goes to H. K. Ferguson Co.

A $650,000 contract for construction at Picatinny Arsenal at Dover, N.J., has been awarded to the H. K. Ferguson Co., industrial engineers and builders of Cleveland. The project, consisting primarily of the installation of process equipment required in the plant operation, is scheduled for completion within six months. The work will be carried out under the direction of the New York District of the Corps of Engineers.

Men with WATER ON THE BRAIN . . .

Harassed
by Hardness . . .

Floored
by Fluorides . . .

Troubled by
Turbidity . . .

Annoyed at
Alkalinity . . .

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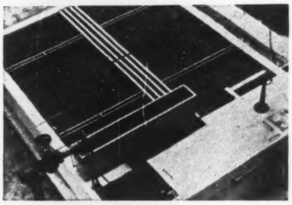
— *should know about the* PERMUTIT PRECIPITATOR!



The Permutit Precipitator brings you a new and more efficient means for removing impurities from water. It does this by precipitation, adsorption, settling and upward filtration. Its sludge blanket is kept fresh and active at all times. The Precipitator requires less space, less time and less chemicals than previous designs of reaction and settling tanks.

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Commerce Field Offices Provide NPA Services

Information on priorities and allocations and other details of the operating program of the National Production Authority may be obtained in Department of Commerce field offices in 59 cities. For local telephone listing, the section devoted to U.S. Government should be consulted. The cities are as follows:

Albuquerque, N. Mex.
Atlanta 3, Ga.
Baltimore 2, Md.
Birmingham, Ala.
Boston 9, Mass.
Buffalo 3, N.Y.
Butte, Mont.
Charleston 3, S.C.
Cheyenne, Wyo.
Chicago 4, Ill.
Cincinnati 2, Ohio
Cleveland 14, Ohio
Columbia, S.C.
Columbus, Ohio
Dallas 2, Tex.
Denver, Colo.
Des Moines 9, Iowa
Detroit 26, Mich.
El Paso, Tex.
Fargo, N. Dak.
Hartford 1, Conn.
Houston 14, Tex.
Jackson, Miss.
Jacksonville 1, Fla.
Kansas City 6, Mo.
Los Angeles 12, Calif.
Louisville 2, Ky.
Manchester 2, N.H.
Memphis 3, Tenn.
Miami 32, Fla.
Milwaukee 2, Wis.
Minneapolis 1, Minn.
Mobile 10, Ala.
Newark, N.J.
New Orleans 12, La.
New York 4, N.Y.
Oklahoma City 2, Okla.
Omaha 2, Nebr.
Philadelphia 6, Pa.
Phoenix, Ariz.
Pittsburgh 19, Pa.
Portland 4, Oreg.
Providence 3, R.I.
Reno, Nev.
Richmond 19, Va.
Rochester, N.Y.
St. Louis 1, Mo.
Salt Lake City 1, Utah
San Antonio, Tex.
San Diego, Calif.
San Francisco 11, Calif.
Savannah, Ga.
Seattle 4, Wash.
Spokane, Wash.
Syracuse, N.Y.
Tampa, Fla.
Trenton, N.J.
Wilmington, Del.
Worcester, Mass.

An NPA booklet on "Inventory Control and Priorities" is available from the Government Printing Office, Washington 25, D.C.

Public Works Projects Get Advance Planning Funds

Four large-scale public works projects, to cost an estimated $24,307,389, will receive a total of $647,720 in federal funds for advance planning under the authorization of the Housing and Home Finance Agency. All conform to present government criteria that projects either fit into national defense needs or meet essential civilian requirements.

The largest advance, $450,000, has been made available to the Detroit-Wayne Building Authority for the preparation of detailed plans for a city-county office and court building. The Detroit City Hall was built in 1875 and the Wayne County building dates back to 1901. Both are reported to be entirely inadequate to meet increased local and county governmental activities necessitated by the defense effort and consequent growth of population in the area. Harley, Ellington and Day, of Detroit, are the architects.

The other planning advances will go for a $1,623,040 State Police Headquarters near Indianapolis; a $1,419,284 improvement to the water-works system of Torrance, Calif.; and a $2,192,600 sewage-treatment plant at Geddes, N.Y. The latter project is part of a major sanitation program for the elimination of pollution from Lake Onondaga.

DECEASED

Oscar August Anderson (M. '45) civil and structural engineer in the Light Division of the Department of Public Utilities, at Tacoma, Wash., died there on December 19. His age was 55. Earlier Mr. Anderson had been chief of the structural steel design section on the construction of the $23,000,000 Nisqually Power Development for Tacoma.

Henrietta Wolf Bernhard (Jun. M. '50) engineer in the Soil Mechanics Department of Turnpike Engineers, at Newark, N.J., was killed in the recent Pennsylvania Railroad wreck at Woodbridge, N.J. She was 22. A graduate of the Newark College of Engineering, Mrs. Bernhard had been married less than a year.

Alfred Brahdy (M. '33) chief engineer in the design division of the Board of Transportation of the City of New York, died on December 27, at the age of 64. Mr. Brahdy had been connected with the Board of Transportation since 1910. He also served as consulting engineer on rapid transit for Buenos Aires, Chicago, and San Francisco. His papers on subway engineering appeared in CIVIL ENGINEERING and other technical periodicals. He received his engineering education at Cooper Union and Brooklyn Polytechnic Institute.

Reuben Francis Brown (Assoc. M. '45) for the past seven years superintendent of sewer maintenance and operations for the Department of Public Works, in Los Angeles, Calif., died recently. He was 59. He had been engaged by the City of Los Angeles in various engineering capacities since 1922.

Wendell Phillips Brown (M. '02) Lakewood, Ohio, consultant, died on January 31. He was 84 and a graduate of the Sheffield Scientific School of Yale University. Mr. Brown began his engineering career with the King Bridge Co., of Cleveland, where he later designed and built bridges for various railroads and municipalities. He then became chief civil engineer for the Wilbur Watson Engineering Co. In 1921 he established his own firm, Wendell P. Brown Co., consulting engineers and architects.

Ernest Brown Coulson (M. '24) for a number of years construction engineer for the Utah Engineering Co., Ogden, Utah, died at his son's home in Charleston, S. C., on January 13. His age was 77. Mr. Coulson worked on the design and construction of dams and the location and construction of railroads. He was a graduate of Kansas State College.

Clermont C. Covert (Assoc. M. '09) general sales engineer for W. & L. E. Gurley, of Troy, N.Y., died in Binghamton, N.Y., on December 11. He was 78 and a graduate of Ohio Northern University. In 1923 Mr. Covert joined the Gurley organization as hydraulic engineer and subsequently became manager of the New York office until it closed in 1948. He was responsible for several improvements in the Price pattern current meter, as well as graphic water level recorders.

Alvin Sayles Cutler (M. '31) professor emeritus and former head of the civil engineering department at the University of Minnesota, Minneapolis, died on January 6, at the age of 71. Mr. Cutler joined the university staff as an instructor in 1907, advancing through the various academic ranks until he was named head of the civil engineering department in 1943. He retired in 1947. He was a graduate of the University of Minnesota.

Leon Snell Dixon (M. '23) consulting engineer, of East Hampden, Me., died in New York, N.Y., on December 10, at the age of 64. Upon his graduation from the University of Maine in 1911, Mr. Dixon entered the employ of the Great Northern Paper Co. For the past 25 years he had been affiliated with E. B. Eddy Co., Ltd., Stone & Webster Engineering Corp., the Newport News Shipbuilding and Drydock Co., and others.

Harold Irving Eaton (M. '28) vice-president and treasurer of the Eastern Engineering Co., at Atlantic City, N.J., died there on January 13. He was 63 and a graduate of the Massachusetts Institute of Technology. Mr. Eaton served on the New Jersey Mosquito Extermination Commission.

Horace Whiting Gregory (M. '26) for some years manager of Armco Drainage & Metal Products, Inc., at Missoula, Mont., died there on January 5. His age was 66. From 1923 to 1927 Mr. Gregory was chief engineer for the Idaho Highway Department. He served in the Army during World War I, attaining the rank of colonel. Earlier he had engaged in private practice, specializing in power and irrigation development. He received his engineering training at the University of Iowa.

S. G. Martin

Sidney Griswold Martin (M. '48) structural engineer for the Freyn Engineering Co., Chicago, Ill., died there on December 14, at the age of 62. He received his engineering degrees from the University of Illinois. For several years Mr. Martin was in charge of the design of railroad structures in Chicago for DeLeuw, Cather & Co., including terminal buildings for the Baltimore & Ohio Railroad at East St. Louis, Ill. Prior to that he had been connected with the Illinois Division of Highways and the Universal Atlas Cement Co.

Wynn Meredith (M. '09) partner in the firm of Sanderson & Porter, engineers and constructors, of San Francisco, Calif., died at his home in Oakland, on December 21. His age was 86. He attended the college of engineering of the University of Illinois. In 1906 Mr. Meredith was retained by Sanderson & Porter as consultant on West-

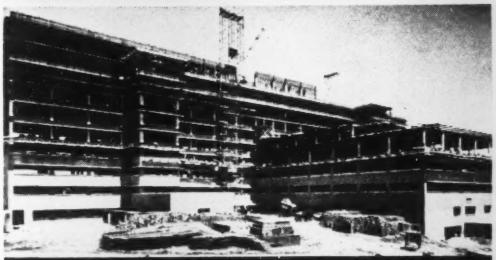
(Continued on page 68)

Factory and salesroom, Olson Rug Co., Chicago

Library, Houston University, Houston, Tex.

J. C. Penney Co. retail store, Indianapolis, Ind.

Marcy apartment houses, Brooklyn, N. Y.


Veterans Administration Hospital, Iowa City, Iowa

State office building, Jackson, Miss.

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...economical for structures of any size or purpose

The photographs above showing six different kinds of buildings illustrate how well adapted reinforced concrete frame and floor construction is for structures of any size or purpose.

Whatever the building size, function or location, you can make important savings in construction costs by using reinforced concrete frames and floors. These savings are possible in buildings of six stories or less as well as in tall structures of all types.

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A national organization to improve and extend the uses of portland cement and concrete through scientific research and engineering field work

Deceased

(Continued from page 66)

ern hydroelectric projects and two years later became a member of the firm in charge of the San Francisco office. He directed the design and construction of hydroelectric installations for the British Columbia Electric Railways and of the water supply for the city of Victoria, B.C. A pioneer in building hot-oil pipelines Mr. Meredith also invented electrical and hydraulic equipment.

Oscar Charles Merrill (M. '13) retired engineer, of Chevy Chase, Md., died in Washington, D.C., on January 15. He was 76 and a graduate of the Massachusetts Institute of Technology. An expert on power, Dr. Merrill drafted the original Water Power Act of 1920 and was the first executive secretary of the Federal Power Commission. He had been chief engineer of the U.S. Forest Service, and later engineer-economist of the United States-Mexico Oil Commission. Before retiring in 1943 he served as principal engineer on the Army Engineering Board.

Seward Merrill Savage (Assoc. M. '08) designer for the Department of Public Works, of Chicago, Ill., died there on December 24, at the age of 70. He was a graduate of the Columbia University School of Mines. Mr. Savage's earlier experience included service as a resident engineer on the New York State Barge Canal project and as general manager and chief engineer of the Central Dredging Co. Later he acted as consulting engineer on the design of the cofferdams for the LaSalle Street Bridge, Chicago, and on the development of the $35,000,000 water supply program for communities in the Chicago area.

Ernest Osgood Sweetser (M. '30) professor emeritus and retired head of the Washington University Department of Civil Engineering, St. Louis, Mo., died on January 18. He was 67. Joining the university faculty in 1905 as an instructor, Mr. Sweetser successively became assistant professor in 1910, associate professor in 1919, professor in 1925, and head of the department in 1933. Professor Sweetser specialized in bridge structures and building materials. During World War I he served in the Army Corps of Engineers. He was a past-president of the St. Louis Section of the Society.

Ernest O. Sweetser

John Godfrey Spielman (M. '30) retired consulting engineer, of Long Beach, Calif., died there on January 3, at the age of 88. He graduated from the University of Iowa. Before going to Long Beach, Mr. Spielman engaged in railroad engineering and bridge construction and was employed by the Illinois Steel Co. He had also been chief engineer and manager of the Pittsburgh, Pa., plant of the American Bridge Co. For many years he was director of the Long Beach Chamber of Commerce.

Ellis Wing Taylor (M. '41) architect and structural engineer, of Los Angeles, Calif., died on January 20. His age was 63. Soon after graduation from the University of California, Mr. Taylor formed a partnership with Edward Cray Taylor in Los Angeles. He designed and supervised the construction of commercial and public buildings, aircraft plants, and pedestrian and vehicular bridges—constructed in connection with the Consolidated Aircraft's manufacturing plant in San Diego. He was a member of the Structural Engineering Association of Southern California.

George Conklin Thompson (Jun. M. '46) engineer-inspector for the Southern Pacific Railroad Co., at San Francisco, Calif., drowned while working on a project near Lowell, Oreg. He was 25. Mr. Thompson graduated from the University of Southern California in 1945, and during the war was an ensign in the U.S. Naval Reserve.

NEWS OF ENGINEERS

Samuel R. Sapirie is now manager of the Atomic Energy Commission's Oak Ridge Operations, Oak Ridge, Tenn. Since 1949 Mr. Sapirie has been serving as deputy manager of the Oak Ridge Operations. He was assigned to the Manhattan Engineer District at Oak Ridge in 1946 as assistant director of operations, and later became chief of the operations division. When the atomic energy program was transferred from the Manhattan District to the AEC, he was placed in charge of production and engineering.

John E. Bernhardt, formerly engineer of structures for the Chicago & Eastern Illinois Railroad, Chicago, Ill., has been appointed chief engineer of the engineering and contracting firm of William J. Howard, Inc., with headquarters in Chicago.

Samuel Shulits is now associate professor of civil engineering at Michigan College of Mining and Technology and not assistant professor as was erroneously stated in the January issue. Formerly Professor Shulits was with the Bipartite Control Office, Frankfort, Germany, as deputy chief of the Plans and International Affairs Section of the transport group that administered the German federal transport system.

Donald C. Peters has been elected president of the Mellon-Stuart Co., Pittsburgh, Pa. Formerly Mr. Peters was vice-president and part owner of Crump Inc., of Pittsburgh.

J. E. Hoving, until recently district engineer for the Northern Pacific Railway, St. Paul, Minn., is now special engineer to the president there.

Harland Bartholomew, consulting engineer to the City Plan Commission, St. Louis, Mo., was recently awarded honorary membership in the American Society of Landscape Architects.

Alfred Rheinstein, president of the Rheinstein Construction Co., New York City, was recently elected first vice-president of the Building Contractors' and Mason Builders' Association of Greater New York.

W. R. Bjorklund, for a number of years with the Northern Pacific Railway Co., has been named principal assistant engineer, at St. Paul, Minn.

A. R. Ellis has been elected chairman of the board of the Pittsburgh Testing Laboratory, Pittsburgh, Pa., which he has been serving as president. He joined the laboratory in 1905 as a technician and has been inspector, chief engineer, and general manager. He is a member of the American Society for Testing Materials and the American Council of Commercial Laboratories.

A. R. Ellis

Wallace L. Chadwick, for the past five years manager of engineering for the Southern California Edison Co., at Los Angeles, Calif., has been elected vice-president in charge of engineering and construction there. Except for service as engineer and senior engineer with the Metropolitan Water District from 1931 to 1937, Mr. Chadwick has been connected with the Edison Co. in several engineering capacities since 1922. He has been active in the Society and the Los Angeles Section and currently is serving as ASCE Director from District 11.

Wallace L. Chadwick

Fred G. Fellows, civil and industrial engineer, of Ponca City, Okla., announces that his office is now located at 1017½ W. Highland in that city. Recently Mr. Fellows was elected president of the Oklahoma Society of Professional Engineers.

Frank E. Baxter has been named manager of the department of purchases and stores of the Pacific Gas & Electric Co., San Francisco, Calif., succeeding the late **Frank R. Sherwood.** Mr. Baxter joined the organization in 1921 and has served successively as assistant engineer in the bureau of specifications and estimates, engineer on the staff of the vice-president and general manager, and since last July as acting manager of purchases and stores.

(Continued on page 72)

The Surveyor's Notebook

Reporting on Unusual Surveying Problems and Their Solutions

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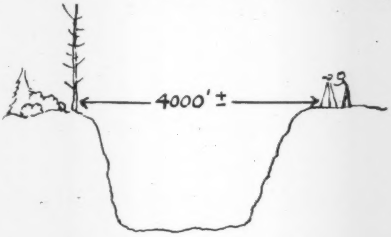

"'**Point your transits** toward Montreal and *get there, double fast!*'–those were orders," recalls Gordon E. Ainsworth, Whately, Mass., surveyor on the original Portland-Montreal oil pipeline, completed in record time back in 1941. "We worked in the field 12 to 14 hours, 7 days a week–through unmapped swamps, mountains and virgin wilderness of northern New Hampshire and Vermont.

"One miserably hot day we hit 'blowdown' in the most impenetrable country I've seen in 21 years of surveying. Levels showed our original line, following a winding mountain road, was 130 feet above the hydraulic gradient established by Humble engineers. Relocating, we faced a deep, wide ravine. Pipe stringers were hot on our heels–there was no time for cutting lines.

"We decided on an approximate check, by stadia, of the elevation on the far side. No rod was available, but hurried reconnaissance turned up a tall beech on the opposite ridge. Exposing the entire length of trunk, we placed red flagging at its base, and aimed the lower cross-hair of our Gurley 'light-mountain transit' at the top of the band. Three of the boys climbed the tree and, at signals from my revolver, moved a second band, which I caught with the upper cross-hair. We got our reading (approx. 40′) by taping the vertical distance along the trunk; found the ravine to be about 4000′ across. After we carefully read the vertical angle and computed the difference in elevation between H.I. and base of tree, direct leveling gave us our proper location in relation to hydraulic gradient.

"We finished the survey for our 83-mile spread in 10 weeks. Oil was flowing the 236 miles into Montreal only 21 weeks after the first stake was driven in Portland!"

Ainsworth Uses Four Gurley Transits

Today, 10 years later, Ainsworth finds *this same Gurley Transit* "easy to handle...easy to adjust." Now surveying New England spreads on the natural-gas pipeline from Texas, he has 4 Gurley Transits on the job. One, purchased second-hand 15 years ago, is used for his most accurate work. "Since we base surveys on azimuths, the accuracy of the Gurley compass is especially important," he says. "Frankly, for land surveying or construction layout, there is no better instrument at any price."

Take a tip from Gordon Ainsworth's notebook. Learn about versatile Gurley Transits. Bulletin 50 gives all details.

SURVEYORS: We'd like your story for a future page in The Surveyor's Notebook. Just drop us a line....We'll contact you for details later.

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Now Is the Time to Make Your Availability Known to Your Personnel Service!

Our registrations of men available are at an all-time low. Many fine executive and engineering opportunities are available for which the Service does not have the personnel to recommend. Therefore, if you are unemployed or seeking a better opportunity, contact the nearest office of the Engineering Societies Personnel Service, Inc., New York, Chicago, Detroit, or San Francisco.

The opportunity you have been waiting for may be waiting for you now!—Alfred H. Meyer, Executive Director.

Men Available

ENGINEER, licensed P.E., M. ASCE, college graduate; 26 years structural design, estimating, hydraulic and sanitary experience; desires responsible position with reputable firm in New York City or in northern New Jersey. C-653.

CIVIL ENGINEER; Jun. M. ASCE; B.E., Sydney; 27; single; Dutch; a year's experience in reinforced concrete, structural and hydraulic design on hydroelectric projects; 6 months' experience irrigation surveys. Desires position in United States. C-654.

CIVIL ENGINEER; Jun. M. ASCE; B.S.C.E., University of Michigan, June 1949; majored in structural courses; desires work in actual construction; 27; single; willing to travel. Has worked in maintenance of way department of major railroad since graduation. Assistant supervisor of track with experience in directing the work of foremen and laborers. C-655.

ENGINEERING SUPERVISOR-PROJECT ENGINEER; Assoc. M. ASCE; 36; married; licensed P.E.; structural engineering graduate; 13 years' experience design, and construction of steel and reinforced concrete structures, including 4 years with structural fabricator; last 6 years in responsible charge of design power plants and substations. Desires to locate on West Coast; now in Midwest. C-656-511-A-5-San Francisco.

CIVIL ENGINEER; M. ASCE; 47; married; registered South Dakota and Alaska; B.S. in C.E., cum laude, 1924, University of South Dakota; over 16 years with major oil company; district superintendent construction and equipment; 10 years civil engineer for U.S. Government on military construction and maintenance. Qualified area supervisor construction and maintenance for major organization. C-657-511-A-11-San Francisco.

CIVIL ENGINEER; Jun. M. ASCE; 24; veteran; married; B.C.E., 1949; experience in field engineering summer months 1942–1944 and 1946–1949; 1 year civil engineer with TVA field engineers doing steam plant construction; drafting and office experience. Interested in highway and airport construction, water and sewage installations, contracting, photogrammetry leading to consulting career. C-658.

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WANTED

Structural engineers for pulp and paper mill design including mill layout and structural steel and reinforced concrete design. In first letter give complete engineering experience, age, education, etc. Address Construction Engineer, P.O. Box 1844, Savannah, Ga.

Positions Available

Engineers. (*a*) Construction Engineer with considerable experience, who has had complete charge of the construction of high-straight-gravity dams with large-sized tunnels and powerhouses. (*b*) Construction Superintendent-in charge with respect to the tunnels to be built in conjunction with this dam. The dam to be constructed will be 680-ft high-straight-gravity dam with large tunnels and powerhouses. Duration, 5 years. Salary open, including furnished living quarters. Location, India. Y-4461.

Structural Designer, 30-40, single preferred, with civil or mechanical degree and 8 years' structural design and drafting experience. Structural designer with refinery experience preferred. Will design, draft, and check structures of steel, reinforced concrete or timber, including mill buildings, trestles, pipe supports, piers, wharves, tanks, etc. Will make necessary field investigations of existing structures and determine safe loads as well as make recommendations for necessary repairs. Salary, $7,320-$9,280 a year. Location, Netherlands West Indies. Y-4738.

Chief Structural Engineer, 35-45, to head up a structural design department for engineering company in the building field. Salary, $8,000-$10,000 a year. Location, New York, N.Y. Y-4787.

Bridge Engineer, civil graduate, with at least 10 years' professional civil engineering experience, including 4 years in responsible charge of highway bridge design, and 2 years in supervision of bridge construction, to act as principal assistant to the county engineer, with the responsibilities of technical and administrative head of the bridge engineering division. Duties involve the design, supervision of construction, and maintenance of bridges and culverts in the county highway system. Salary, $6,500 a year to start. Location, New Jersey. Y-4796.

Engineers. (*a*) Structural Design Engineer and Detail Draftsmen with several years' experience and able to produce design results in the field of rigid frame steel buildings. (*b*) Estimators, with some experience in the cost of structural steel fabrication. Will train young college graduates interested in this field, who might be desirous of working in sales capacity later on. (*c*) Field Superintendents, preferably college graduates, for the erection of simple industrial buildings throughout the eastern half of the United States. Location, Pennsylvania. Y-4873.

Structural Designers, steel and concrete, on power plant work for large firm of construction engineers specializing in public utility work. Salary, $6,000 a year depending on experience. Location, New York, N.Y. Y-4882.

Sanitary and Hydraulic Engineer, graduate, with broad experience in the design of sewage and water treatment plants and related sanitary and hydraulic projects. Work will include preliminary studies, reports and preparation of specifications for consulting firm. Opportunity for advancement. Location, Ohio. Y-4885.

Civil Engineers with 3 to 4 years' practical experience in the field for foreign work in the eastern Atlantic area, for building of airfields, industrial buildings, sewerage, water supply, etc. Contract, 2 years. Salary, $4,600-$6,400 a year, plus allowances from $1,000-$1,500. May take family later. Y-4896.

Construction Engineer, preferably under 35, for company engaged in the construction of industrial buildings. Will be responsible for central office control of all engineering projects. Civil engineering degree with experience in good construction company. Salary, about $10,000 with bonus. Location, Midwest. Y-4910.

Structural Designers, 24-45, with 4 years of college, or equivalent, specializing in structural engineering. Should have 3 to 7 years' experience and be capable of producing complete engineered designs of structural steel and concrete for industrial plants, machine pits and foundations, platforms, etc.; designing and preparing working drawings from notes and sketches; estimating cost of construction, steel and concrete work. When necessary, will make field investigations and take field measurements. Possibly some travel. Salary, $3,750-$5,800 a year depending upon experience. Company will pay placement fee. Location, New Jersey. Y-4941.

Civil Engineer with degree in civil engineering or equivalent, including or supplemented by courses

(*Continued on page 72*)

Pick this Lightweight for **Heavyweight** drilling!

Like all Acker Drills, this lightweight husky was designed and built to operate under the most rugged conditions.

If you are looking for a quality drill that will give you years of trouble-free operation—*you want the Acker Teredo.*

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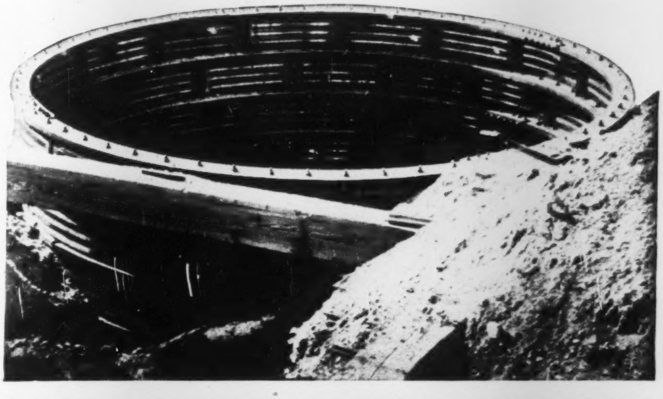

THE COMMERCIAL SHEARING AND STAMPING CO.
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Positions Available

(Continued from page 71)

in sanitary engineering; plus 3 years' experience in survey work, one year of which must have been in a supervisory position; plus eligibility for Maryland registration as a land surveyor. Will supervise and inspect work of contractors engaged in making topographic, property and other surveys of state property. Salary, $4,200 $5,200 a year. Location, Maryland. Y-4977.

ENGINEERS. (*a*) Field Assistants; preferably engineering graduates, over 30, for field investigations on engineering or other projects under direction of senior engineers. Salaries, $9,390 $10,055 a year plus living allowance. Paid vacation at the end of contract on basis of 1 month for each year. Two-year contract. Location, Indonesia. (*b*) Assistant Engineer, mechanical, with a minimum of 15 years' industrial experience. Will assist senior engineer on survey work and reports. Salary $13,146 a year, plus living allowance. Paid vacation at the end of contract on basis of 1 month for each year. Two-year contract. Location, Indonesia. Y-4983.

SOILS TECHNICIAN, college graduate, specialist and thoroughly familiar with the latest theories and practices in analysis of soils for dam construction. Should be capable of taking charge of and be responsible for the field soils laboratory and should be thoroughly familiar with all the inspection requirements for earth, rock, and other foundation and embankment materials. Salary, $7,200 a year. Location, Massachusetts. Y-5008(*c*).

News of Engineers

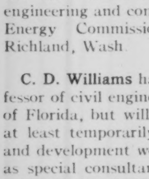
(Continued from page 68)

John I. Thomas, who has been project engineer for Pine Flat Dam in California, has been named chief of the division of engineering and construction at the Atomic Energy Commission's Hanford Works, Richland, Wash.

C. D. Williams has resigned as head professor of civil engineering at the University of Florida, but will remain on the faculty, at least temporarily, to carry on research and development work. He is now serving as special consultant to the firm of Reynolds, Smith & Hills on the $16,000,000 Jacksonville Bridge program.

John C. Riedel, chief engineer for the Board of Estimate, New York, N.Y., was honored recently for 50 years of service to the city. The board passed a resolution commending him "for his great service to the people of the city."

Ole Singstad, New York consultant, and **David G. Baillie,** formerly senior civil engineer with the Triborough Bridge & Tunnel Authority, New York City, have formed a partnership under the firm name of Singstad & Baillie, with headquarters in New York, N.Y.



V. W. Russell

V. W. Russell, engineer for the Bureau of Reclamation, at Ephrata, Wash., has retired after 41 years of government service. Mr. Russell was guest of honor at a recent dinner given by his friends and coworkers. He has served on many of the Bureau's reclamation developments, including the Yakima project.

John J. Nanry, retired civil engineer, of Pearl River, N.Y., has been appointed to the Orangetown Planning Board and the Zoning Board of Appeals in that community. Mr. Nanry retired last May after 43 years of work in the construction of aqueducts, bridges, heavy underpinning, and rapid transit and vehicular tunnels.

Henry G. Gerdes, colonel, Corps of Engineers, area engineer, Salt Lake Area, Salt Lake City, Utah, in charge of construction at Dugway, has been appointed to the Order of the British Empire with the degree of honorary officer.

G. G. Greulich

G. G. Greulich, until recently consulting engineer in the specialty products division of the U.S. Steel Co., at Pittsburgh, Pa., has opened an office at 610 DuPont Circle Building, Washington, D.C. He will represent the Drilled-In Caisson Corp., the W. E. O'Neil Construction Co., the Union Metal Manufacturing Co., the Western Foundation Co. He still maintains a consulting office in Pittsburgh.

Thomas J. Fowler, partner in the firm of Fowler-Veranth Construction Co., at Duluth, Minn., has been named local deputy director of civil defense in charge of engineering.

ASCE members elected to office at the annual meeting of the W. J. Barney Corp., New York, N.Y., included **Wm. Joshua Barney,** chairman of the board; **Alfred T. Glassett,** president; and **Wm. Joshua Barney, Jr.,** executive vice-president.

D. J. Niotis

D. J. Niotis, previously structural designer with the Mines Engineering Co., at Chicago, Ill., has assumed new duties as structural engineer and designer for F. H. McGraw & Co., engineers and contractors. Mr. Niotis will be engaged on the extension of the present plant and construction of a new power plant of the Linde Air Products Company in East Chicago, Ind.

William C. Ready, colonel, Corps of Engineers, U.S. Army, has been assigned to the post of deputy division engineer, North Atlantic Division, New York, N.Y. He was previously on duty as executive officer to the president of the Beach Erosion Board, in Washington, D.C. He has also served as chief of operations of the Honolulu Engineering District during the construction of the $40,000,000 Tripler General Hospital.

Robert G. Deitrich, formerly structural field engineer for the Portland Cement Association in Maryland and Delaware, has become an associate in the firm of J. L. Faisant & Associates, Inc., Baltimore, Md.

Newman B. Smith

Newman B. Smith, for the past five years city engineer of San Gabriel, Calif., has been made chief engineer of the Riverside County (California) Flood Control and Water Conservation District. Mr. Smith was connected with the Metropolitan Water District of Southern California during the construction of the Colorado River Aqueduct.

Lester B. Dunlap, previously engineer for the Sutter-Butte Canal Co., at Gridley, Calif., has become engineer for the Oroville-Wyandotte Irrigation District, Oroville, Calif., replacing **Dean P. Larson,** who has been granted a leave of absence for military service.

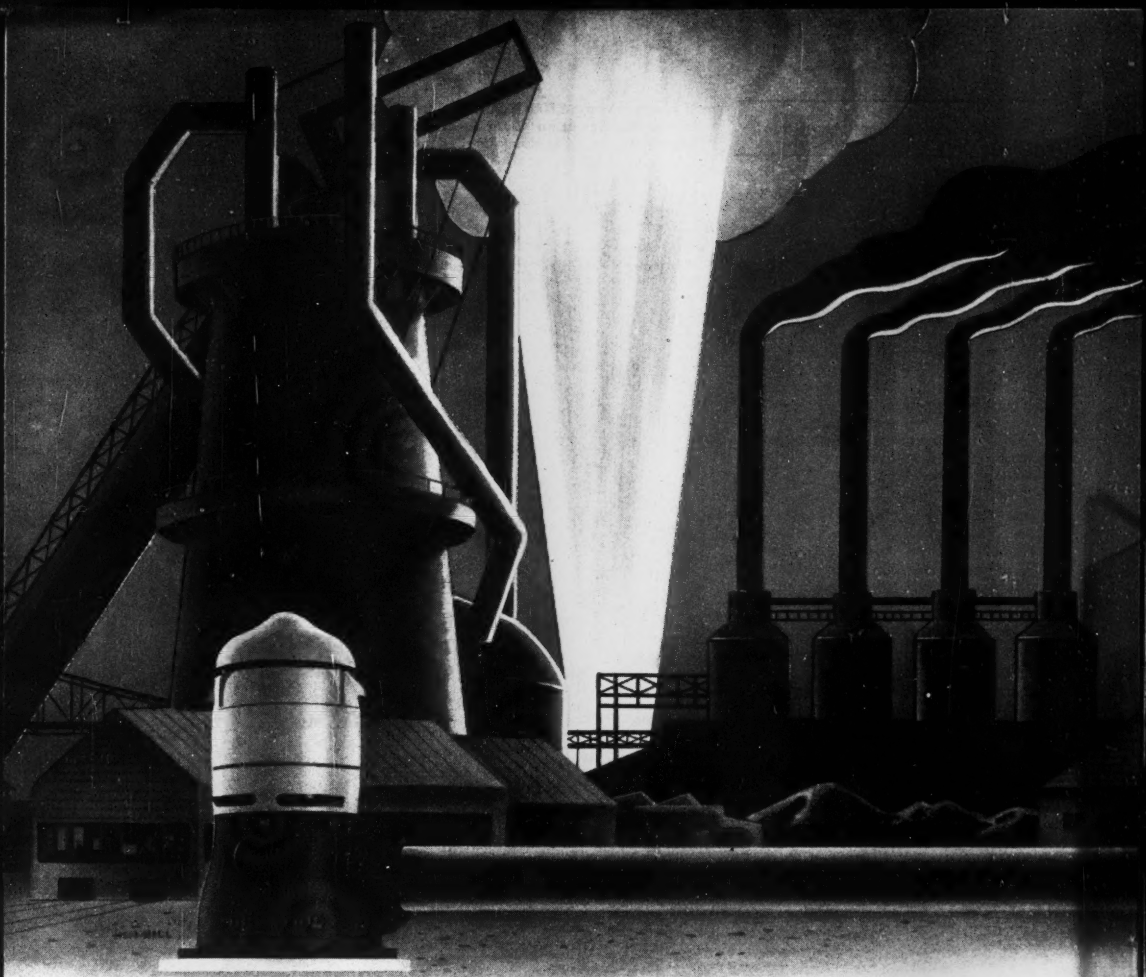
Theodore Human is now in Rangoon, Burma, where he is serving as supervising engineer for the Mingaladon Aerodrome Construction Committee on construction of the city's airport. The airport—reported to be the World's fifth largest—will be a Class V CAA field with 8,100-ft runways. Christiani & Nielsen Ltd. hold the construction contract.

Frank A. Kittredge, chief engineer of the National Park Service, Washington, D.C., was recently awarded the Pugsley Silver Medal of the American Scenic and Historic Preservation Society. Cited as a "distinguished engineer and administrator," Mr. Kittredge has been in the National Park Service since 1924. He was active in design and construction of the Going-to-the-Sun Highway and in establishment of the Kings Canyon National Park, and was superintendent of Grand Canyon and Yosemite National Parks before his transfer to Washington as chief engineer.

James Kip Finch, former dean and Renwick Professor of Civil Engineering in the Columbia University School of Engineering, has been accorded emeritus status by the trustees. Dean Emeritus Finch, who was retired last June under the automatic retirement system, has since returned to the classroom to teach courses in Engineering and Western Civilization and Structural Aesthetics.

Hugh J. Casey, major general, Corps of Engineers, U.S. Army, has been named assistant to the president of Schenley Laboratories, Inc., New York, N.Y. He previously was executive vice-president of the Pennsylvania Hospital in Philadelphia and before that was chief engineer for General of the Army, Douglas MacArthur.

John E. Buxton, member of the consulting firm of Buxton & Allen, Little Rock, Ark., has been named state manager of the National Production Authority. In this capacity Mr. Buxton will assist manufacturers and producers—particularly the smaller ones—to obtain metals and other materials needed during the national emergency.



HOW MUCH WATER IN A TON OF STEEL?

Of all the raw materials used in making steel, water is by far the largest single component. From blast furnaces to rollers, 120 tons of water are used to make one ton of steel. Johnston Engineers do not pretend to be steel men, construction men or civil engineers, but they do know how to move water—where you want it... when you want it. In construction work, as in the steel industry, Johnston Vertical Pumps have been the economical and dependable solution to many fluid-handling problems. Whether your pumping application calls for big gallonage or small, high lift or low... our hydraulic engineers will demonstrate how a Johnston can save money on your job. *Johnston Pump Company, 2324 East 49th Street, Los Angeles 58, California.* *DEALERS IN ALL PRINCIPAL CITIES.*

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CLOSE-COUPLED TURBINES For Industrial Applications

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VERTICAL PUMPS For Volatile Fluids and Hot Liquids

Positions Announced

State Department of Public Improvement, Maryland. The Maryland State Department of Public Improvement announces openings in the classification of Civil Engineer II, with a yearly salary of $4,200–$5,250. Duties will include supervising and inspecting work of contractors engaged in making topographic, property, and other surveys of state property. To qualify, applicants must have graduated from a recognized college or university with a degree in civil engineering and option in sanitary engineering. In addition, three years of experience in survey work is necessary. Inquiries should be addressed to the State Employment Commissioner, 31 Light Street, Baltimore 2, Md.

U.S. Naval Laboratory, Port Hueneme, Calif. The U.S. Naval Civil Engineering Research and Evaluation Laboratory at Port Hueneme, Calif., reports numerous openings in civil and other engineering fields. These include positions as Construction Engineer (GS-7), with yearly salary $3,825–$4,575; Materials Engineer (GS-9), with yearly salary $4,600–$5,350; Materials Engineer (GS-5), with yearly salary $3,100–$3,850; and General Engineer (GS-14), with yearly salary, $8,800–$9,800. Applications should be sent to Clyde B. Carter, Director, Personnel Division of the Laboratory, Construction Battalion Center, Port Hueneme, Calif.

Bureau of Yards and Docks, Washington, D.C. Vacancies exist in the Bureau of Yards and Docks, Washington, D.C., and elsewhere in the United States. The positions will be concerned with design, construction, inspection, and maintenance of naval shore establishments, with base salaries from $3,100–$6,400 per annum. Civil Service Form 57 should be submitted to the Employment Section, Bureau of Yards and Docks, Department of the Navy, Washington, D.C.

Civil Service Commission, Illinois. Announcement of examinations for Civil Engineers I through V has been made by the Illinois Civil Service Commission. Final date for applying is March 23 and the tentative date for written tests is April 14. Other details may be obtained from Maude Myers, President, Civil Service Commission, Springfield, Ill.

Corps of Engineers. The Portland, Oreg., District of the Corps of Engineers is recruiting civilian personnel in the various engineering fields for work in connection with the Department of Army construction and rehabilitation program in overseas areas. Opportunities exist in Okinawa, Japan, Guam, Austria, Germany, France, Trieste, and Turkey. For further information write to the District Engineer, Portland District, Corps of Engineers, 628 Pittock Block, Portland 5, Oreg.

Mare Island Naval Shipyard, Vallejo, Calif. Applications are being accepted by the U.S. Civil Service Commission for engineering and technical employment at the Mare Island Naval Shipyard. Positions range from GS-7 level through GS-11, with starting salaries from $3,825–$5,400 per annum. Inquiries regarding these positions and requests for civil service application forms should be made to the Employment Superintendent, Mare Island Naval Shipyard, Vallejo, Calif.

Engineer Research and Development Laboratories, Fort Belvoir, Va. Civilian positions for more than 300 engineers and other technical personnel are available at the Army's Engineer Research and Development Laboratories at Fort Belvoir, Va. The positions—civil and photogrammetric engineers, architects, technical writers, and others—carry salaries up to $6,400 a year. A completed Civil Service Form 57, which may be obtained from any Civil Service Commission office or local post office, should be addressed to the Commanding Officer, Engineer Research and Development Laboratories, Fort Belvoir, Va.

RECENT BOOKS

Bruckenbauer Der Reichsbahn

A short history of the development of bridge construction is covered by A. Hertwig in *Bruckenbauer Der Reichsbahn* by means of biographical sketches of four noteworthy German designers—J. W. Schwedler, H. Zimmermann, J. Labes and G. Schaper. In addition, the book discusses the major design features of their bridges and contains a list of their publications and reprints of their outstanding articles. (Verlag von Wilhelm Ernst & Sohn, Berlin, 1950. 154 pages, 15 DM; bound, 17.50 DM. Also for sale by European Periodicals Publicity and Advertising Co., Ltd., 41-45 Neal St., London, W.C. 2.)

Cofferdams

Based on the practical experience of the authors, L. White and E. A. Prentis, *Cofferdams* is devoted to the essentials of scientific cofferdam design and construction. The hydrodynamics of cofferdams, erosion in streams, lateral earth pressures, land cofferdams, practical construction details, and economic aspects are considered. This revised edition also contains five new descriptions of actual cofferdam construction, new references in the bibliography, and a glossary of terms. Columbia University Press, New York, N.Y., 1950. 311 pages, $10.

Die Gleitschalung

A collection of information on various concrete construction methods, providing a critical review with specific examples of situations in which sliding forms are used, is presented by W. Drechsel in *Die Gleitschalung*. The volume is of value to the designing engineer who is primarily concerned with developing the most economical, yet safest type of structure. Numerous photographs and sketches illustrate the text. Verlag von Wilhelm Ernst & Sohn, Berlin, 1950. 95 pages, 10 DM.

Die Neue Theorie des Stahlbetons auf Grund der Bildsamkeit vor dem Bruch

The main sections of this reference work on reinforced concrete by R. Salinger cover the following subjects: Basic principles, tension and compression members; prestressed concrete beams; external loads; and shear resistance and connections. Emphasis is placed on the results of experiments, and new material has been added on crack formation and the effects of shrinkage and creep in this third edition. Franz Deuticke, Vienna, 1950. 135 pages, $2.80.

Dynamik des Bogenträgers und Kreisringes

Characteristics and mathematical principles of arched girders and circular rings are described in *Dynamik des Bogentragers und Kreisringes* by K. Federhofer. The book considers the natural frequency of thin rods with a circularly bent axis and also the free vibrations of a bent rod which, in the stress-free state, had the form of either a closed ring or a part of one. (Springer-Verlag, Vienna, 1950. 179 pages, $5.50.)

Economic Aspects of Atomic Power

The economic effects which would be produced by the use of atomic power for the production of electricity or heat are examined in an exploratory study performed under the direction of S. H. Schurr and J. Marschak. Entitled *Economic Aspects of Atomic Power*, the book begins with questions on the technical feasibility and economics of atomic power. The cost is then compared, for various areas of the world, with the cost of electricity from conventional sources. This analysis is followed by a study of the potential applicability of atomic power in selected industries. It concludes with a parallel study on national and regional economics and on the industrialization of so-called backward areas. (Published for the Cowles Commission for Research in Economics by Princeton University Press, Princeton, N.J., 1950. 289 pages, $6.)

German-English Technical and Engineering Dictionary

Covering all fields of engineering and technology, this new book, *German-English Technical and Engineering Dictionary*, by L. DeVries, contains more than 125,000 entries. It makes available in book form for the first time, many new words taken from glossaries compiled by various research workers and translators for their own use. There is also a 36-page alphabetical list of German abbreviations, with their English equivalents, at the end of the volume. (McGraw-Hill Book Co., New York, Toronto, London, 1950. 928 pages, $20.)

Man the Maker

The development of modern technical achievements is explained as an aspect of the broader history of civilization and culture in *Man the Maker* by R. J. Forbes. The discoveries and inventions of prehistory, the ancient East, the Greeks and Romans, the Arabs, the Middle Ages, the 16th and 17th Centuries, the Industrial Revolution, and the modern era are discussed. In each case, the close relationship between pure science and engineering and technology is indicated. (Henry Schuman, Inc., 20 East 70th St., New York, 1950. 355 pages, $4.)

Manual of British Water Supply Practice

Compiled by the Institution of Water Engineers and edited by A. T. Hobbs, the *Manual of British Water Supply Practice* is an authoritative survey of sound water supply practice. Separate groups of British experts have covered in 25 chapters a full range of the subject from hydrology and hydrogeology to the financial, legal and management aspects of water supply plants. Reservoirs, aqueducts, wells, pumping plants, and distribution systems are dealt with, as well as all phases of water treatment and examination. (W. Heffer & Sons, Ltd. Cambridge, England, 1950. 910 pages, 50 ; distributed in the United States by the American Water Works Association, 500 Fifth Avenue, New York, N.Y., $7.50.)

(Continued on page 78)

AS THE YEARS ROLL ON

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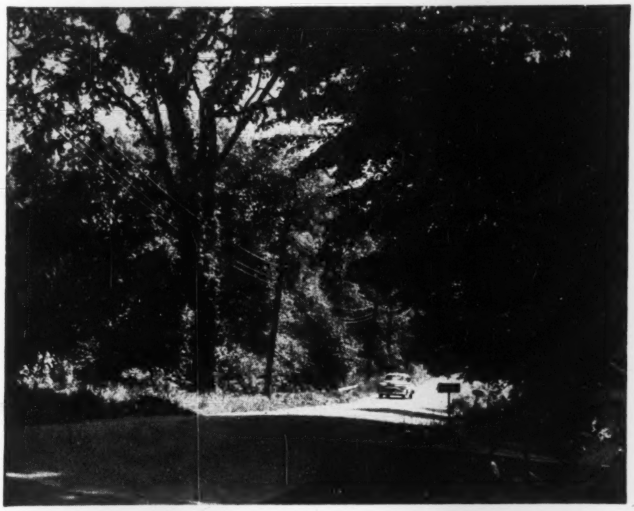

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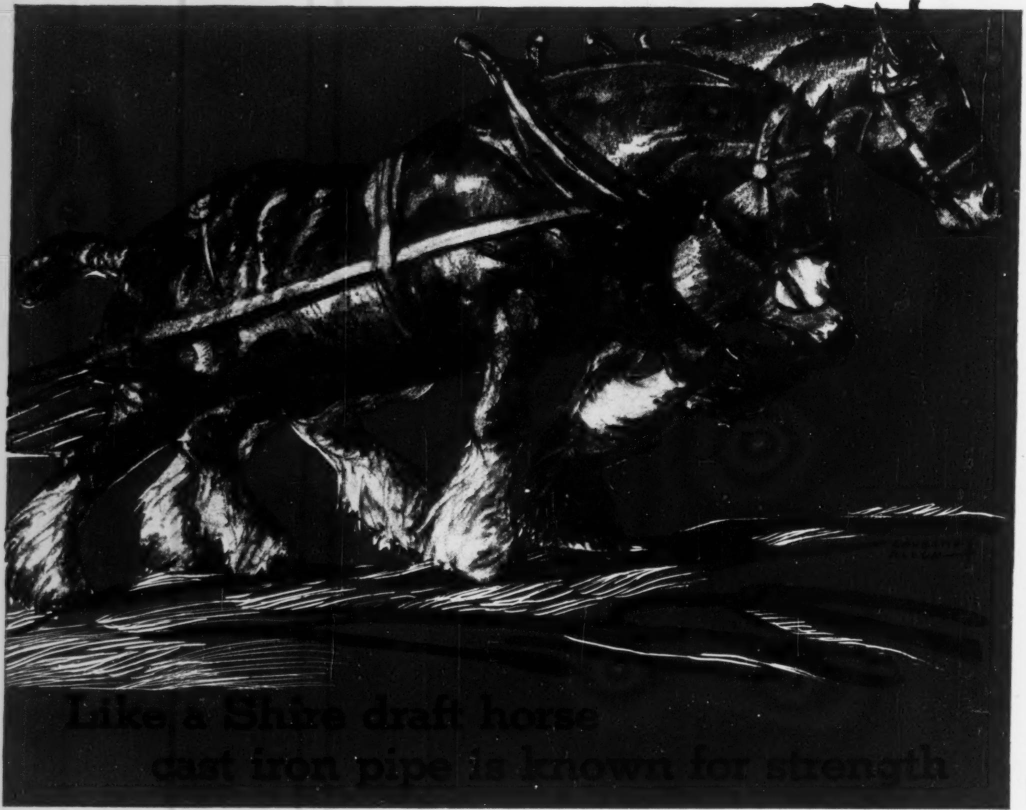
Like a Shire draft horse
cast iron pipe is known for strength

The strengths demanded of pipe to be laid under expensive modern pavements, if costly repairs and replacements are to be avoided, are known strengths—proved by experience and determinable by tests. The four strength factors that pipe must have to withstand beam stresses, external loads, traffic shocks and abnormal working pressures are listed on the opposite page. *No pipe, deficient in any of these strength factors, should ever be laid in paved streets of cities, towns or villages!* Cast iron water and gas mains, laid over a century ago, are serving today in the streets of 30 or more cities. These service records prove that cast iron pipe not only resists corrosion but has all the vital strength factors of long life and economy.

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No pipe that is deficient in any of the following strength factors should ever be laid under paved streets.

CRUSHING STRENGTH

The ability of cast iron pipe to withstand external loads imposed by heavy fill and unusual traffic loads is proved by the Ring Compression Test. Standard 6-inch cast iron pipe withstands a crushing weight of more than 14,000 lbs. per foot.

BEAM STRENGTH

When cast iron pipe is subjected to beam stress caused by soil settlement, or disturbance of soil by other utilities, or resting on an obstruction, tests prove that standard 6-inch cast iron pipe in 10-foot span sustains a load of 15,000 lbs.

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The toughness of cast iron pipe which enables it to withstand impact and traffic shocks, as well as the hazards in handling, is demonstrated by the Impact Test. While under hydrostatic pressure and the heavy blows from a 50 pound hammer, standard 6-inch cast iron pipe does not crack until the hammer is dropped 6 times *on the same spot* from progressively increased heights of 6 inches.

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In full length bursting tests standard 6-inch cast iron pipe withstands more than 2500 lbs. per square inch internal hydrostatic pressure, which proves ample ability to resist water-hammer or unusual working pressures.

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SERVES FOR CENTURIES

Recent Books

(Continued from page 74)

Municipal Affairs

Discussions of the fundamentals of city government, functions of the various departments, and the technique of administration are presented by E. W. Steel in *Municipal Affairs*. Special attention is given to the problems of utilities including those municipally owned. One chapter is devoted to city planning. In this second edition, new techniques and statistics are added to conform with present conditions and recent developments in the financing of city improvements. (International Textbook Co., Scranton, Pa., 1950. 377 pages, $5.50.)

National Research Council, Highway Research Board

Papers and reports presented at the 1949 Annual Meeting of the Highway Research Board, which were not published elsewhere, are made available in the *Proceedings of the 29th Annual Meeting* at Washington, D.C., December 13-16, 1949. The papers are grouped under six broad classifications as follows: Economics, finance, and administration; design; materials and construction; maintenance; traffic and operations; and soils. The major emphasis in the volume is on soil investigations. (National Research Council, Washington, D.C., 1950. 620 pages, $7.50.)

(The) Properties of Asphaltic Bitumen

This book, edited by J. Ph. Pfeiffer, acquaints the reader with the modern views regarding the structure of bitumen as a colloidal system and the explanation which they offer of its physical and chemical properties. How this knowledge can be employed in determining the most suitable types of bitumen to be used in the various technical applications, is also indicated. (Elsevier Publishing Co., New York, Amsterdam, London, Brussels, 1950. 285 pages, $6.)

Public Health Engineering

In the second of the two-volume work, *Public Health Engineering*, E. B. Phelps and associates discuss those principles of sanitation which, applied to the production, handling and distribution of food, have direct public health significance. The general principles of food handling and serving are illustrated by a consideration of sanitary practices in public eating and drinking places. Rodent control and the handling and disposal of garbage, refuse and municipal wastes are also discussed. (John Wiley & Sons, New York; Chapman & Hall, Ltd., London, 1950. 213 pages, $4.)

Safety in Electric and Gas Welding and Cutting Operations

The American Standard Z49.1-1950 covers regulations for the safe installation and operation of welding equipment for arc, gas and resistance welding processes. Provisions are included for fire prevention and protection in regularly assigned welding areas and in other locations as well. Precautions are specified for the welding of materials which may give off toxic fumes and for welding in confined areas. (American Welding Society, 29 West 39th St., New York 18, N.Y., 1950. 42 pages, 50 cents.)

State-City Relationships in Highway Affairs

This report by N. Hebden and W. S. Smith on a research project, which examined and evaluated the administrative policies and procedures employed in state-city highway work and studied existing practices and the ways in which they were evolved, is called *State-City Relationships in Highway Affairs*. Twelve states and 22 cities were studied, using the following subject fields: Organization for highway work, financial aid for cities, authority for urban work, extent of state activities in cities, working procedures, and personal attitudes and appraisals. (Yale University Press, New Haven, Conn., 1950. 230 pages, $4.)

Technological Applications of Statistics

Based on a series of lectures delivered at the Massachusetts Institute of Technology, *Technological Applications of Statistics* by L. H. C. Tippett is an introduction to statistical methods applied to technological problems. Part I deals with routine control of quality and covers the measurement of quality, various aspects of control charts, and acceptance sampling. Part II treats the topics of investigation and experimentation and provides information on the statistical theory of errors, applications of the analysis of variance and of correlation analysis, and the planning of an investigation. (John Wiley & Sons, New York; Williams & Norgate, Ltd., London, 189 pages, $3.50.)

Theory of Modern Steel Structures

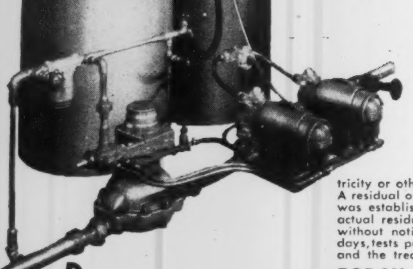
Written by L. E. Grinter as an abridgment to his first two volumes on the subject, much of the material on statically indeterminate structures has been eliminated. The book discusses bridges and roof trusses, towers and commercial buildings, and devotes a chapter to deflections and influence lines. It will be particularly adaptable as a textbook for accelerated courses in structural engineering. (The Macmillen Co., New York, 1950. 424 pages, $6.50.)

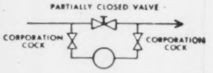
Water Quality and Treatment

The revised and enlarged edition of the American Water Works Association manual, *Water Quality and Treatment*, provides up-to-date material prepared by leading authorities in each branch of the field of water purification. Additions are made to all of the chapters, which cover such topics as the characteristics of available water sources, and natural and artificial methods of water treatment for industrial and human use. Extensive reference lists follow each chapter, and a bibliography of books on all aspects of water supply is included at the end of the text. (American Water Works Association, 500 Fifth Ave., New York, N.Y., 1950. 451 pages, $5.)

CHLORINE DIOXIDE TREATMENT

A PAINLESS CURE for a Sick Water Works





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New Publications

Traffic Engineering. Prepared under a grant of the Eno Foundation as a joint research project of the Bureau of Highway Traffic, Yale University, and the Eno Foundation, *A Volume Warrant For Urban Stop Signs*, is a study on the effective use of stop signs to regulate traffic. The authors, Morton S. Raff and Jack W. Hart, conducted their research in New Haven, Conn. Inquiries should be addressed to the Eno Foundation for Highway Traffic Control, Saugatuck, Conn.

Zoning Ordinances. Copies of the *Zoning Ordinance for the Maryland-Washington Regional District in Prince George's County, Md.*, enacted by the County Commissioners on November 29, 1949, and printed by the Maryland National Capital Park and Planning Commission, Prince George's County Regional Office, Riverdale, Md., are available for $2 each.

Inter-American Technical Studies. Issuance of a quarterly review instituted to encourage Latin-American bibliographical studies by disseminating information about authors, publications, and libraries is announced by the Pan-American Union, Washington, D.C. It employs the four official languages of the organization of American States—Spanish, English, Portuguese, and French. The annual subscription rate is $3, and single issues 75 cents in United States currency. Orders may be sent to the Publications and Promotion Section of the Pan-American Union, Washington 6, D.C.

Earthquake Resistant Designs. Reprints of *Earthquake Resistant Design of Building Structures and Tank Towers* by H. M. Engle and John E. Shield, prepared for the Pacific Fire Rating Bureau, are now available without charge to those directly engaged in the design of structures. A number of additions such as photographs of the recent Pacific Northwest shock, and an extended list of notable Pacific Coast earthquakes are included. Inquiries should be addressed to the Pacific Fire Rating Bureau, 465 California Street, San Francisco, Calif.

Airfield Maintenance. Typical installations of bitumuls asphalt paving are described in a new bulletin, *Bitumuls for Airfields*, for those interested in airfield planning, construction, paving or maintenance. Available free on request, from either the Stancal Asphalt and Bitumuls Co. (west of the Rockies) or the American Bitumuls Co. (for the East) 200 Bush St., San Francisco 4, Calif.

War Standards. The decisive role that standardization played in World War II is described in a booklet of the American Standards Association called *Standards for America's Engineers.* The booklet also indicates some of the tremendous gaps that must be filled if we are to make the best use of American resources, and tells of the work now going on in war standards. Inquiries should be addressed to the American Standards Association, 70 East 45th Street, New York 17, N.Y.

Sedimentation Studies. Investigations of the rates of sediment production from small watershed areas, for use in the design of floodwater detention structures in the Little Sioux River Watershed, are reported by the U. S. Soil Conservation Service in *Sediment Design Criteria for the Missouri Basin Loess Hills.* The studies are described by L. C. Gottschalk, head of the Sedimentation Section, Office of Research, and Gunnar M. Brunne, of the Water Conservation Division, Region III. Inquiries should be addressed to H. H. Bennett, Chief, Soil Conservation Service, U.S. Department of Agriculture, Washington, D.C.

Soil Testing. Through the work of ASTM Committee D-18 on Soils for Engineering Purposes, 17 standardized methods of soil testing are described in this extensive compilation, *Procedures for Testing Soils.* The price for nine copies or less is $3.75 per copy and ten to 49 copies, $2.80. The charge for ASTM members is $2.80 and $2.25, respectively. Address all requests to the American Society for Testing Materials, 1916 Race St., Philadelphia, Pa.

(*Continued on page 80*)

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By EDMUND ASTLEY PRENTIS and LAZARUS WHITE

The new edition of this authoritative technical description of underpinning methods and applications for foundation construction has been extensively revised and brought completely up-to-date. The authors describe in detail actual cases of every type of underpinning.

The volume also contains an introductory treatise on soil mechanics, nearly 200 photographs and drawings, and appendices which include among other information, specifications, legal aspects of underpinning and foundation work, and a glossary of terms. Underpinning is considered the authoritative source for information in the field by engineers, architects, and contractors all over the world. **Price $10.00**

COFFERDAMS

Second Edition, Revised and Enlarged, published by Columbia University Press

By LAZARUS WHITE and EDMUND ASTLEY PRENTIS

Cofferdams is the only engineering book devoted entirely to the design of cofferdams.

Presentation is made of theoretical considerations of the hydrodynamics of seepage forces, stream erosion, and lateral earth pressures for cofferdams on land and in water. Actual design and construction features are presented by detailed case studies of cofferdams which have come under the authors' supervision. Construction equipment, pumping stations, sheetpiling of wood and steel, bracing systems, excavation methods are among the features described. Actual cases of pitfalls and failures, as well as successes, are given.

This new edition contains 201 photographs, and drawings, a glossary of terms and a bibliography. **Price $10.00**

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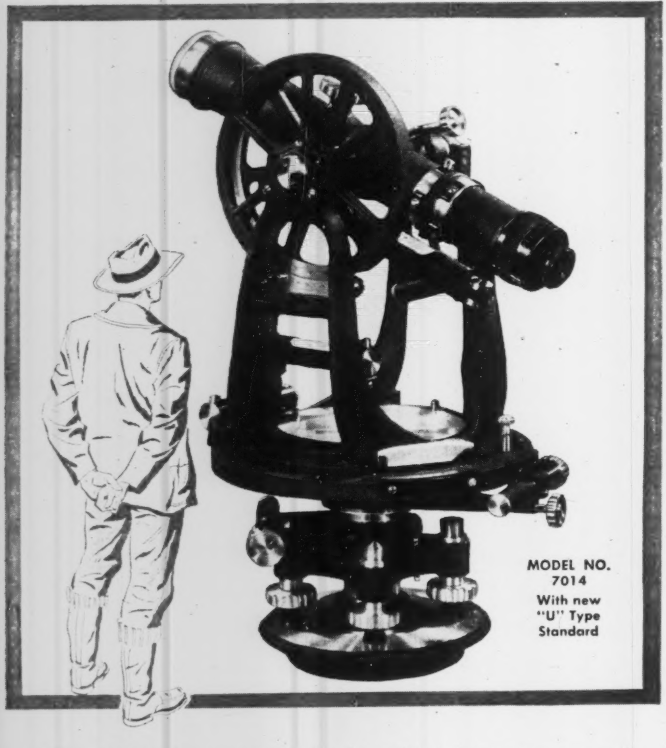

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New Publications

(Continued from page 79)

Highway Engineering. Bulletin No. 46 of the Utah Engineering Experimental Station consists of the *Proceedings of the Eleventh Annual Highway Engineering Conference*, compiled and edited by A. Diefendorf. The papers and program are dedicated to "Better Highways for the West." Further information may be obtained by writing to the University of Utah, School of Engineering, Salt Lake City, Utah.

Hydraulic Studies. Recent publications of the St. Anthony Falls Hydraulic Laboratory include Technical Papers Nos. 3, 4, and 5 of Series B—*Hydraulic Data Comparison of Concrete and Corrugated Metal Culvert Pipes*, *Hydraulic Tests in Concrete Culvert Pipes*, and *Hydraulic Tests on Corrugated Metal Culvert Pipes*—by Lorenz G. Straub and Henry M. Morris, priced at 35 cents each; Project Report No. 24, describing hydraulic model studies for Whiting Field Naval Air Station conducted in cooperation with the U.S. Soil Conservation Service and the Minnesota Agricultural Experiment Station; and Part V, *Studies of Open-Channel Junctions*, by Charles E. Bowers, priced at 80 cents. All inquiries should be addressed to the St. Anthony Falls Hydraulic Laboratory, Hennepin Island, Minneapolis 14, Minn.

Soil Exploration and Mapping. Information on the status of geological and agricultural soil mapping is presented by the Highway Research Board in Bulletin No. 28, *Soil Exploration and Mapping*. The names of geologists and soil scientists who may be able to assist the engineer in using this material are listed by states for ready reference. Address all inquiries to the Highway Research Board, 2101 Constitution Avenue, Washington, D.C.

Metric Conversion Chart. Free copies of a *Metric Wall Chart* for converting meters to feet and inches, and feet and inches to meters may be obtained upon request to Robert S. Mayo, Lancaster, Pa.

Railway Bibliography. The fourth edition of the *Bibliography of Railway Literature*, compiled by the Association of American Railroads, covers juvenile books, general literature, model railroading, railway statistics, railway and travel periodicals, and railway employee periodicals. Write to the Association of American Railroads, Washington, D.C., for information concerning the booklet.

Evaporation Theory. An interim report on Lake Mead Water Losses, entitled *A Review of Evaporation Theory and Development of Instrumentation*, reviews all evaporation equations based on mass transfer and energy-budget approaches and describes instrumentation developed and modified for experimental test selected equations. E. P. Anderson, L. J. Anderson, and J. J. Marciano, of the Applied Research Division of the U.S. Navy Electronics Laboratory, San Diego, Calif., are the authors of the report. Copies are available free on request to the Chief Hydraulic Engineer, U.S. Geological Survey, Washington 25, D.C.

Hydraulic Research Facilities. The St. Anthony Falls Hydraulic Laboratory has issued Circular No. 5 describing its current research and facilities. The charge for this well-illustrated booklet, limited in distribution, is $1 per copy. Inquiries should be addressed to St. Anthony Falls Hydraulic Laboratory, Hennepin Island, Minneapolis 14, Minn.

Boston Society of Civil Engineers. Availability of a *Cumulative Index to Journals*, Volumes I to XXXV (1914–1948) of the Boston Society of Civil Engineers is announced by the Society, 715 Tremont Temple, Boston, Mass. Copies are $2 each.

Welding Safety. Elimination of welding hazards is the aim of the new American Standard Z49.1-1950, described in *Safety in Electric and Gas Welding and Cutting Operations*. Sponsored and published by the American Welding Society, the Standard may be purchased for 50 cents from the headquarters of the AWS, 33 West 39th Street, or the American Standards Association, Inc., 70 East 45th Street, New York, N.Y.

Institute on Street and Highway Problems. Urban, county, traffic, construction, and maintenance problems are discussed in the *Proceedings of the Second California Institute on Street and Highway Problems*, held at the University of California in 1950. The Proceedings are now available from the Institute of Transportation and Traffic Engineering, University of California, Berkeley, Calif., at $1 each.

Meetings and Conferences

American Road Builders' Association. Headquarters for the 48th annual meeting of the American Road Builders' Association will be the Schroeder Hotel, Milwaukee, Wis., March 12–14.

American Society of Mechanical Engineers. The spring meeting of the American Society of Mechanical Engineers will take place at the Atlanta-Biltmore Hotel, Atlanta, Ga., April 2–5.

Materials Handling Conference and Exposition. New handling techniques will be discussed at the materials handling conference, which will take place concurrently with the national materials handling exposition at the International Amphitheatre, Chicago, Ill., April 30–May 4. The conference is being sponsored by the American Material Handling Society and the exposition by the Material Handling Institute.

Society of Automotive Engineers. The second annual earthmoving industry conference will be held in conjunction with the Central Illinois Section meeting of the Society of Automotive Engineers, in Peoria, Ill., April 10 and 11.

Applications for Admission to ASCE, Jan. 6–27, 1951

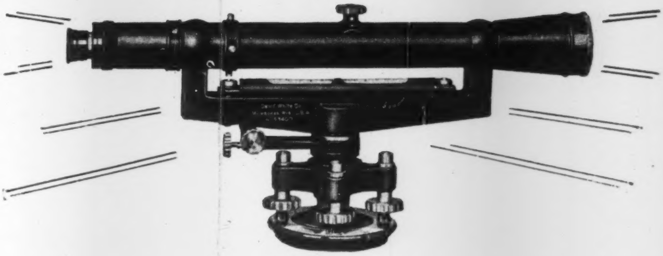
Applying for Member

Arner, Reinhold William, Harrisburg, Pa.
Barker, William Earl, Austin, Tex.
Barr, Charles Melville, Seattle, Wash.
Beach, James Clarence, New Haven, Conn.
Carboine, Francis Anthony, Augusta, Me.
Church, William Campbell Gibson, Washington, D.C.
De Serio, James Nicolas, Buffalo, N.Y.
Fanta, Joseph Maximilian, New York, N.Y.
Glover, Malcolm, London, England
Hahn, Marion, Lincoln, Nebr.
Hardesty, James Robert, Newark, N.J., and Washington, D.C.
Hedrick, Wyatt Cephas, Fort Worth, Tex.
Hershkowitz, Leon, Rolla, Mo.
Irving, Charles Curran, Chicago, Ill.
Lewis, John Albert, Bryan, Tex.
Loggins, Lee Alston, Houston, Tex.
MacKenzie, Vernon Gordon, Cincinnati, Ohio
Matheus, Jose Angel, Caracas, Venezuela
McFaul, William Lawrence, Hamilton, Ont., Canada
Meyer, Grant Edward, Missoula, Mont.
Neeper, Guy Enoch, Toledo, Ohio
Parker, Isaac Curtiss, Seattle, Wash.
Powers, Roger Tyler, Towson, Md.
Romanski, Edward Josef, Mendoza, Argentina
Schwartz, Earl Dum, Harrisburg, Pa.
Sorrell, William Hiram, Fort Wayne, Ind.
Wheeler, Will Watie, Tulsa, Okla.
Young, Jacob Clough, Sacramento, Calif.

Applying for Associate Member

Astleford, William Roy, Kansas City, Mo.
Bartel, Fred Frank, Milwaukee, Wis.
Beaven, Luis Fernando, Chicago, Ill.
Chittenden, Simeon Dudley, Baltimore, Md.
Clark, John Hallett, 3rd, Louisville, Ky.
Clingerman, John Wakefield, Pittsburgh, Pa.
Duarte, Eduardo Garcez, Troy, N.Y.
Fisher, David, Elverta, Calif.
Kalappa, Kanuparthl, Madras, India
Kirkby, Eustace Antony, Antofagasta, Chile

(*Continued on page 82*)



Compare before you buy

David White 18" Dumpy levels give you more features for less money

Look at the chart of important engineering and construction features of the David White 18" Dumpy Level given below. Compare those features, item for item, with every other recognized make of instrument. Then compare prices. You'll see why we say David White 18" Dumpy Levels give you more quality, more advantages important to you in your work for less money. See your nearest David White dealer for complete details on this and other equally fine engineering instruments or write direct to David White Co., 359 W. Court St., Milwaukee 3, Wisconsin.

Features	D. White No. 7080	Instrument A	Instrument B
Magnifying Power of Telescope	35X	30X	27X
Distance away you can read 1/100 ft. graduation	1200 ft.	1050 ft.	900 ft.
Diameter of objective lens	1.81 in.	1.485 in.	1.69 in.
Field of view (In minutes of arc)	64'	52'	60'
Coated optics	YES	YES	YES
Covered Leveling Screws	YES	YES	YES
Can you easily replace worn leveling screws in the field?	YES	NO	YES
Sensitivity of level vial (in seconds of arc per 2mm of graduation)	20"	20"	25"
Price — Complete with carrying case, tripod and accessories — F.O.B. factory	$280.00	higher	higher

DAVID WHITE COMPANY

We offer complete, prompt repair service on all makes of instruments — levels, transits, theodolites, etc.

**Prices subject to change without notice.*

359 West Court Street
Milwaukee, Wisconsin

How to keep Line "FEATHERS" out of your hair!

It was a clean, sharp line till it had to be erased. But when it was re-inked, brother how it feathered and "blobbed"!

Feathering lines are one of the things you *don't* have to worry about with Arkwright Tracing Cloth. Even erased surfaces will take a neat, sharp line. What's more, you'll never find pinholes, thick threads or other imperfections in Arkwright cloth. You'll never have to fear that your drawings will discolor, go brittle or become opaque with age. A drawing on Arkwright Tracing Cloth will yield clean, clear blue-prints years after you make it.

Aren't your drawings worth this extra protection? Arkwright Finishing Co., Providence, R.I.

Arkwright
PENCIL CLOTH
WHITE
Arkwright
TRACING CLOTH
Matsur
PENCIL TRACING

ARKWRIGHT
Tracing Cloths
AMERICA'S STANDARD FOR OVER 25 YEARS

ASCE Applications

(*Continued from page 81*)

Lefoldt, Martin Emil, New York, N.Y.
Minchey, John William, Chattanooga, Tenn.
Montgomery, John Henry, Austin, Tex.
Murphy, John Joseph, Buffalo, N.Y.
Nothstine, Leo Vaughn, Flint, Mich.
Roberts, Wyndham John, Champaign, Ill.
Rohwedder, Eugene Frederick, Baltimore, Md.
Rucker, Joshua Eldon, Lynchburg, Va.
Strand, John Andrew, Madison, Wis.
Sucre Alemán, Oscar Alberto, Caracas, Venezuela.
Venkatraman, Mehadeva Ayyer, Madras, India.
Wengenroth, Reece Harden, New York, N.Y.
Wilke, Harvey Robert, Lafayette, Ind.

Applying for Junior Member

Erwin, John Edward, Springs, Wyo.
Gunther, Joseph William, Kansas City, Mo.
Gyi, Khin Maung, New Orleans, La.
Iffland, Jerome Samuel Bissell, New York, N.Y.
Oakes, Donald Leslie Tufnell, New York, N.Y.
Rengel Gil, Alejandro, Denver, Colo.
Resnick, Benjamin, New York, N.Y.
Rodin, Stanley, Urbana, Ill.
Rubick, Stephen Richard, Wilmington, Del.
Sterbenz, Frederick Henry, New York, N.Y.
Tel, Berc Bogos, Istanbul, Turkey.
Young, Zifton H., Jr., Paris, Tex.

ALABAMA POL. INST.

Carter, Carroll Lindon
Carter, Tandy Warren
Fredlund, William Albert
Mattison, George Augustus, 3rd
Rodgers, Henry Gerald
Standridge, James Emmett

UNIV. OF CALIFORNIA

Anderson, James Peter
Bagnall, Lewis Grover, Jr.
Clearwater, Louis Laird
Coburn, Robert Stuart
Fuller, John Cornell
Gilcrest, John
Hans, George Milton
Haskell, Broderick Phelps, Jr.
Hoggan, Harold Robert
Hoppe, Donald Newton
Keim, Seward Russell
McIntyre, Jack Paul
Ramakrishna Raju, Pabbaraju S. R.
Randles, Richard Kenneth
Reynolds, James Bion
Self, James Gilbert
Tarkan, Yusuf Nihat
Wright, John Hacke
Zenoni, William James

UNIV. of COLORADO

Block, Burton Stanley
Consaul, John Lee
Dickinson, Richard Obert
Ham, Charles King
Kassel, Raymond Lee
Livingston, Gordon Browning
Savage, William Percy
Strutzmann, Paul Ernest

UNIV. OF CONNECTICUT

Cronk, Wesley Mortimer

UNIV. OF DETROIT

Byersmith, Louis Arthur, Jr.
DeMarco, Lou
Gammon, Robert Delmar
Gargaro, Robert Donald
Lappo, Teddy
Nash, Joseph Patrick
Orton, Harrison
Sharpe, William Gordon
Shaughnessy, Robert Clarence
Wachowski, Raymond John

GEORGE WASHINGTON UNIV.

Besier, Rudolph Rederick
Hedrick, Robert Kenny

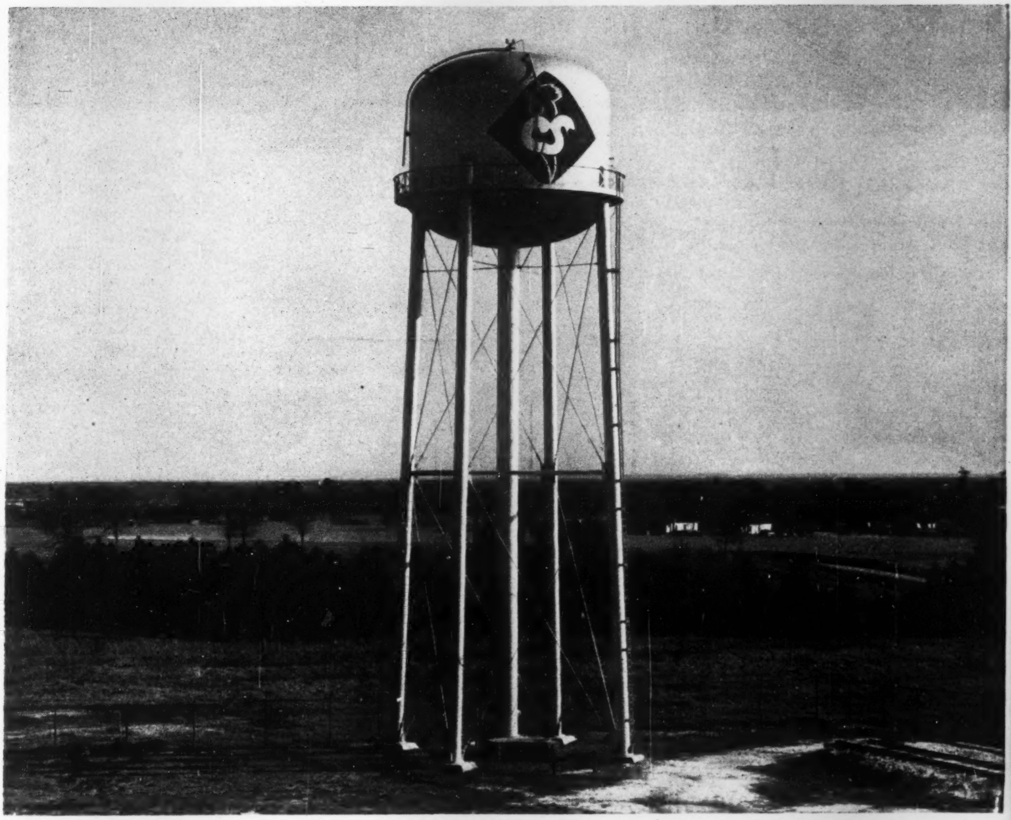
GEORGIA INST. TECH.

Brevetti, Albert Carl
Burnsed, Leroy

IOWA STATE COLL.

Crouse, Clark Dean
Girton, Darrel Dean

(*Continued on page 84*)



Protecting a $1,375,000 Warehouse Inventory

Colonial Stores, Inc., is one of the largest retail food outlets in Dixie. With 366 stores throughout Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, and Tennessee, it provides groceries for thousands of Southern dinner tables.

Behind the scene of this retailing operation are two modern warehouses, which supply Colonial stores with a varied line of foodstuffs. The largest of these distribution units is located in Columbia, South Carolina. It houses an inventory valued at about $1,375,000.

Destruction of even a part of this warehouse food by fire would naturally be a serious loss to Colonial Stores. The finest protection, therefore, is a constant necessity. That's why an automatic sprinkler system and a Horton elevated water tank have been installed. This combination guarantees instant fire protection 24 hours a day, 7 days a week. Water in an elevated tank depends only on natural gravity pressure to flow from sprinklers the instant they open.

Hundreds of factories, warehouses and institutions have adopted this dependable method of better fire protection. As a result many have realized substantial insurance savings that pay for the complete installation in the matter of a few years.

Horton elevated water tanks are of welded steel construction to insure longer life with a minimum of maintenance. Smooth surfaces mean easier painting and more modern appearance.

Horton elevated tanks are built with ellipsoidal-bottoms in standard capacities ranging from 15,000 to 500,000 gallons. Horton Waterspheres are built in capacities from 25,000 to 250,000 gallons. When you require water storage facilities, write our nearest office for estimating figures. Please state capacity required, height to bottom, location and service for which the tank is to be used.

CHICAGO BRIDGE & IRON COMPANY

Atlanta 3	2167 Healey Bldg.
Birmingham 1	1596 N. Fiftieth St.
Boston 10	1009—201 Devonshire St.
Chicago 4	2199 McCormick Bldg.
Cleveland 15	2263 Guildhall Bldg.
Detroit 26	1541 Lafayette Bldg.
Houston 2	2128 National Standard Bldg.
Los Angeles 14	1556 General Petroleum Bldg.
New York 6	3395—165 Broadway Bldg.
Philadelphia 3	1652—1700 Walnut St. Bldg.
Salt Lake City 4	509 West 17th South St.
San Francisco 4	1584—200 Bush St.
Seattle 1	1309 Henry Bldg.
Tulsa 3	1647 Hunt Bldg.
Washington 6, D. C.	Cafritz Bldg.

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNA.

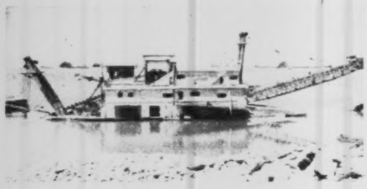
MOVING YOUR DREDGE TO NEW GROUND?
For Efficient Operation
LET YUBA MOVE, REDESIGN AND REBUILD IT!

3 Case Histories Show the Possibilities

REBUILT 3 TIMES

Capital No. 2 (now Biggs No. 2), built in 1906 as YCGF No. 3, has been redesigned and rebuilt 3 times and used in three different areas. Bucket speed was increased from 18.6 to 22.8 feet per minute, bucket capacity increased from 7 to 9 cu. ft., digging depth changed from 60′ to 61½′ and later reduced to 50′, then to 47′. Daily average running time upped from 18.317 to 22.1 hours.

2 DREDGES COMBINED



Biggs No. 1 operating at Rio Bonito, California, with 9 cu. ft. buckets and 50′ digging depth, was assembled in 1935 from the machinery of YUBA No. 48 (erected in 1921 at Fairplay, Colorado) and the rebuilt hull of YCGF No. 4 (Hammonton, California, 1914).

DREDGE MOVED, DIGGING DEPTH CHANGED

Capital No. 3 was originally YUBA No. 39, built in 1916 with 18. cu. ft. buckets and 77′ digging depth, for Hammonton, California. In 1930 it was redesigned, moved to Folsom, California and rebuilt as Capital No. 3 with 62½′ digging depth.

Why guess? Let YUBA help you attain increased efficiency when you move to new ground, or when conditions change and redesign becomes necessary.

Our more than 40 years of bucket ladder dredge experience is available to you for moving, redesigning, and rebuilding old dredges, whether YUBA or not. YUBA's are used all over the world to capture gold, tin, platinum and other minerals, and for aggregate production. Write or wire us NOW. No obligation.

YUBA DREDGES
PROVED DEPENDABILITY ROUND-WORLD

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SHAW DARBY & CO., LTD., 14 & 19 LEADENHALL ST., LONDON, E. C. 3.
CABLES: YUBAMAN, SAN FRANCISCO · SHAWDARBCO, LONDON

ASCE Applications

(Continued from page 82)

Goll, Jacob John
Johnson, Robert Joseph
Kirchner, Ronald Francis
Konrady, Howard Lawrence
Malcom, William James
Oakes, Henry Smith
Prouty, Dow Earl
Schneider, Donald Harry
Shaner, Willis Wheeler

Univ. of Maine

Ring, Chester Allen, 3rd
Simpson, William Harold

Manhattan Coll.

Sheridan, Philip William, Jr.

Marquette Univ.

Connors, Francis Joseph
Delory, Edward Joseph, Jr.
Downs, Charles Oscar
Evans, William Henry
Felker, Charles Lewis
Haglund, Marvin Calvin
Kors, James
McDonald, Ronald Chester
McDonald, Chester Ronald, Jr.
McKeown, John Richard
Nixon, Robert Taylor
Shapiro, Richard Benjamin
Simmet, John Leo
Van Laanen, Richard James Peter
Wieland, Donald George

Univ. of Maryland

Beane, Glenn Parker

Massachusetts Inst. Tech.

Lewis, Jerome Arthur

Univ. of Massachusetts

Murphy, Leon Alexander

Univ. of Michigan

Hu, Lu-Shien

Michigan State Coll.

Foster, Donald Robert
McGinn, Rubert Aloysius, Jr.
Nakamura, Takashi
Zinkel, Robert John

Univ. of Minnesota

Anderson, Gordon David
Jewell, Milton R.
Marpe, Frederick William

Mississippi State Coll.

Gee, Yet Lin

Ohio State Univ.

Hunt, Charles Fredrick
Sablotny, Elbert Theodore

Purdue Univ.

Johnson, Robert Louis

Rutgers Univ.

Lynch, Vernon Eugene

South Dakota State Coll.

Atkinson, Glenn Le Roy
Gelling, William Andres
Swick, Loren Lester

Stanford Univ.

Ingraham, Jack Merritt
Newman, Edwin Robert
Phelps, Robert Chapman

Syracuse Univ.

McGivern, Robert Francis

Univ. of Texas

Rugeley, Robert Selden

Univ. of Virginia

Smith, Thomas Archer

Virginia Pol. Inst.

Anderson, Charles Miller, Jr.

Washington State Coll.

Montgomery, Charles Gerald

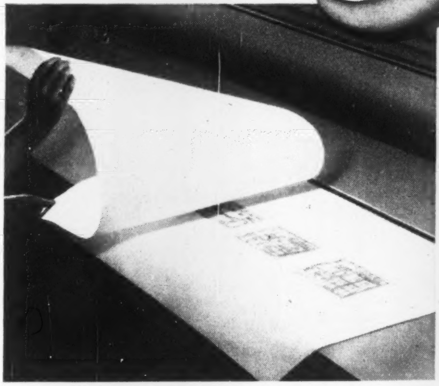
Univ. of Wyoming

Schmidt, Karl Francis

More time for creative drafting!

Look at just two of the ways Kodagraph Autopositive Paper saves valuable drafting time for the Cleveland Crane and Engineering Company.

The chances are you'll be able to take similar short-cuts in your work . . . *turn hours of costly retracing time into hours of creative drafting time.*

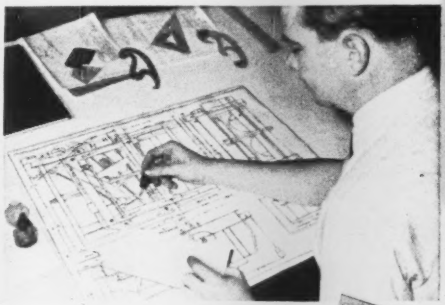


1 Time saved . . . when drawings must be combined

Many clients order custom jobs requiring electrical components which Cleveland Crane must obtain from outside vendors. Oftentimes, the designs for several of these units must be combined in one drawing before original drafting can begin. This used to be a tedious retracing job—*but no longer.* Now, desired sections of the vendors' prints are reproduced as a composite print on "Autopositive" Paper. Exposure is in a direct-process machine; processing is in standard photographic solutions. The result is a sparkling positive intermediate . . . with dense photographic black lines on a clean, evenly translucent base. On it, the draftsman simply adds the necessary wiring detail . . . producing a new "master" in a fraction of the old time.

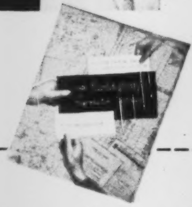
2 Time saved . . . when drawings must be changed

New design must replace old detail on complicated switch assembly drawings. *And Cleveland Crane is doing the job the easy way:* instead of making a new drawing—which would be 85% retracing—they reproduce the original one on Kodagraph Autopositive Paper. Then the draftsman removes the unwanted lines from the intermediate print with corrector fluid . . . and draws in the new detail. Result: a brand-new "original" is ready in three hours instead of 3 days. *Ready* to produce sharp, legible shop prints in the desired number.



Kodagraph Autopositive Paper

"The Big New Plus" in engineering drawing reproduction



—MAIL COUPON FOR FREE BOOKLET—

- **It enables you, or your blueprinter, to produce positive photographic intermediates directly at a new, low cost.**
- **It enables you to reclaim old, weak-lined drawings . . . reproduce opaque originals and prints.**
- **It protects your valuable originals . . . produces more legible shop prints.**

EASTMAN KODAK COMPANY
Industrial Photographic Division, Rochester 4, N. Y.

93

Gentlemen: Please send me a copy of your illustrated booklet giving all the facts on Kodagraph Autopositive Paper.

Name__________ Position__________

Company__________ Street__________

City__________ State__________

Kodak
TRADE-MARK

EQUIPMENT, MATERIALS and METHODS

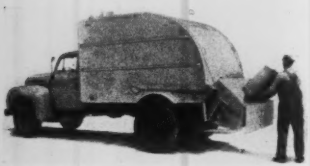
NEW DEVELOPMENTS OF INTEREST AS REPORTED BY MANUFACTURERS

Plants

AN ADDITION TO THE TRAVELER SERIES of gravel crushing, screening and loading plants has been announced. Named the Model CSE Traveler, the plant consists of a jaw crusher, shovel loading hopper with reciprocating feeder and trap grate, feed conveyor, one-deck inclined gyrating screen, delivery conveyor, return bucket elevator, and power unit mounted on a steel gooseneck truck with pneumatic tires. The CSE Traveler is designed to produce accurately sized material for road building and maintenance with a single crusher in a closed circuit. Four sizes are available with 916, 1016, 1020, or 1024 jaw crushers in either bronze or roller bearing types. The Traveler plants are designed for "crush and travel" operations where production requirements are moderate. The complete series of plants now include the CSE, CS and TS. The CS and TS are single-pass gravel plants that screen out finished pit run, crush the oversize, and blend the natural with the crushed material in the loading operation. **Universal Engineering Corp., Cedar Rapids, Iowa.**

Refuse Loader

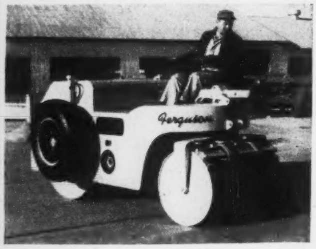
A GREATLY IMPROVED REFUSE LOADER in capacities of 9 cu yds and 12 cu yds is announced. Increased load capacities are provided by virtue of the body design and increased packing ability. Both sizes are for installation on truck chassis of 84 in. cab-to-axle dimension. Bucket size has also been increased and the rubbish packing panel has been given an additional part to play. This full width panel now holds the load in packed position but, during loading, is released as the bucket passes a pair of trip levers. The panel then snaps back instantly, allowing the bucket to discharge its load into the body. Packing is effected on power-down stroke of underbody hoist by means of encased legs extending through the body floor to subframe pedestals. These legs, linked by arms to the packing panel, force it through a positive packing arc. Maintenance is simplified through the fact that all operations of loading, packing and dumping the loader are powered by one double-acting hydraulic cylinder. **St. Paul Hydraulic Hoist, 2207 University Ave., S.E., Minneapolis 14, Minn.**



Available in 9 and 12 Cu Yd Capacities

Roller

A 3 TO 5 TON MAINTENANCE roller that is instantly portable is now being manufactured. Without ballast, the roller weighs three tons and will trail at normal truck speeds on its own wheels, which are raised and lowered by a power-driven hydraulic pump, at the touch of a finger. The towing end of the roller is also raised instantly for attachment to truck by power-driven hydraulic cylinder. With water ballast, it becomes a full five-ton roller. Forward and reverse movement is controlled by a single lever, with two speeds in each direction. It will operate alongside any standard curb without removing transportation wheels, which can be raised 12 in. above bottom of roller. Transportation wheels can easily be removed in two minutes by one man. This permits roller to operate within 4 in. of a fence or wall. Water is controlled by valves within easy reach of operator. Roller is equipped with 75 gal capacity sprinkling water tanks and mats over both rolls. Spring-actuated scrapers are placed at front and back of both rolls. Engine is 4-cylinder, 20 hp, aircooled. **Shovel Supply Co., P.O. Box 1369, Dallas 1, Texas.**



Instantly Portable

Compressor

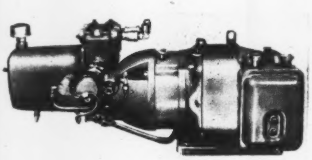
A TWO-STAGED, AIR-COOLED, 30 cu ft capacity compressor with a maximum operating pressure of 150 lbs, is announced. It is equipped with an ASME air receiver, oil bath air cleaners, and protective V-belt guard. Features include: circumferential cooling fins, tube and fin type air-cooled intercooler, positive by-pass unloader holds inlet valve open during idling period, Worthington feather valve, separate, close-grained cast iron honed cylinders, full floating wrist pins, oil dippers for controlled lubrication, aluminum low pressure piston and cast iron high pressure piston of equal weight for proper balance. The compressor is available in either a trailer model having an overall length of $74\,^{5}/_{8}$ in. or a hand truck model with an overall length of 65 in. **Worthington Pump & Machinery Corp., Harrison, N. J.**

Arc Welder and Power Generator

A 300 AMP. GASOLINE ENGINE driven arc welder with a 3 kw auxiliary power generator, popular with the armed forces as a field repair and maintenance unit, is being announced. The arc welder and power generator is a self-contained unit powered by a 6-cylinder self-starting Chrysler industrial engine directly connected to the welding generator and mounted on a welded steel frame. An auxiliary 3 kw power generator provides for lights and such tools as lathes, grinders, drills, brake reliners, valve refacers, chipping hammers, power wrenches, and paint sprayers. The unit is completely enclosed by a sheet metal canopy that is bolted directly to the frame. Hinged side doors provide access to the control panels, the engine, the welding generator and other parts within the canopy. The welding generator is rated at 40-volts, 300 amperes under one hour resistance load at 1500 rpm and has a current range from 50 to 400 amperes. **Hobart Brothers Co., Hobart Square, Troy, Ohio.**

Compact Hydraulic System

A COMPLETELY PACKAGED HYDRAULIC system combines compactness with adaptability for use by large and small plants interested in building simple hydraulic presses, jigs, clamps, or fixtures. The solid coupling of motor and pump eliminates drive belts, lessens repair costs or work stoppage through mechanical breakdown. The design also minimizes pressure flutter and overheating due to maintenance of pilot pressures with large volume installations. More than 100 models offer ranges of 1.8 to 8.25 gpm, pressures up to 1,000 psi. The totally enclosed motor ranges from $^{1}/_{3}$ to 5 hp with manual, electro-pneumatic or hydraulic valve control. The complete unit, which may be used as complete hydraulic system or as pilot system on large installations, includes motor, solid coupling, vane-type pump, reservoir, oil cooler, air filter, overload valve, pressure regulating valve and 3 or 4-way valve or combination of both. **Harco Industries, 20 Curtice St., Rochester 5, N. Y.**



Harco Hydraulic Pump

WOOD WON'T BURN

if it is

CZC(FR)® WOOD

To all the advantages of wood—its easy workability, availability, decorative value, economy, re-use value—is added the important quality of fire-retardance. For CZC (FR) is wood with Koppers Chromated Zinc Chloride (FR) treatment which controls spread of fire and afterglow . . . puts wood in the *fire-safe* class.

Proved in Use

Under actual fire conditions, chemically-protected wood has come through with flying colors. For example, a sudden, fierce fire broke out in a structure built with Koppers Fire Retardant Wood. Not only was the fire quickly brought under control and extinguished, but no serious structural damage resulted.

Resists Decay

Even if you never have a fire, Koppers CZC (FR) Wood is a good investment. It is fortified against decay and termite attack as well as against fire. The Koppers Treatment is odorless, does not greatly change the color of wood, nor interfere with its paintability.

Send for Booklet

Wherever wood is vulnerable to fire, use Koppers CZC (FR) Wood. It helps to protect buildings, contents and people against fire hazards. For complete details send for our free booklet, "Koppers Fire-Retardant Wood."

KOPPERS COMPANY, INC., Pittsburgh 19, Pa.

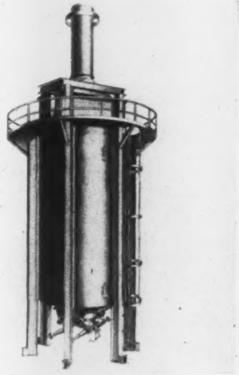
KOPPERS PRESSURE-TREATED WOOD

KOPPERS

Equipment, Materials & Methods (Continued)

Fired Heaters

A STANDARD LINE OF DIRECT fired heaters, capacities 100,000 BTU per hour to 15,000,000 BTU per hour is announced. This equipment is designed for a wide range of applications, including indirect circulating heating using heat transfer mediums such as Dowtherm, and for direct heating of vapors and liquids. Temperatures range to 750 deg F or above. The equipment is designed for high thermal efficiencies and trouble-free operation. Complete automatic control systems are available which largely eliminate operating attention. Operating costs may be compared with those for steam boilers in smaller sizes. Completely engineered systems including all necessary equipment are available if required. If your process requires heat at temperatures above existing steam supply, or if operation may be improved or speeded up by higher temperatures, this equipment will be of interest. The equipment may also be used to supplement existing boiler capacity, or for installation in remote plant locations to save cost of new steam facilities. Ask for Bulletin B-45, **Struthers Wells Corp., Warren, Pa.**



High Thermal Heater

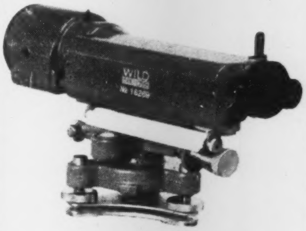
Automatic Door Operator

A SIMPLIFIED TYPE of automatic door operator now enables the average home owner to enjoy all the advantages of garage doors that open or close at the touch of a push button on the dashboard of the car. The device, which fits any Kinnear Rol-Top door and many other similar doors, is operated by a simple electric-magnetic control. A small electric motor raises and lowers the door from inside the garage, by cable and pulley. A magnetic actuating unit placed in the driveway is energized by pressing a control button mounted on the dashboard of the car, which operates through a small magnetic unit usually

(*Continued on page 88*)

BE ON THE LEVEL

WILD
HEERBRUGG



WILD N III

Precision Level WILD N III. A modern fast-working level with highest obtainable accuracy. Height readings to .01 millimeter, also special execution available with reading directly to 1/1000th of an inch. The ideal job-doer for first order levelling, assembling heavy machinery, measuring deformations, verifying rises or depressions in buildings.

FOR THE FULL STORY WRITE OR PHONE
FOR BOOKLET CVE3

Complete repair & servicing facilities by factory specialists.

HENRY WILD
SURVEYING INSTRUMENT SUPPLY CO.
OF AMERICA, INC.
26 COURT ST., BROOKLYN 2, N. Y. TRiangle 5-0644

. . . because it's

HANDY

to use

and carry

a BRUNTON POCKET TRANSIT
should be with you every day

It is always ready for a rough survey,
a quick check on grade or level,
or a hundred other tasks.
Because it has frequent application
on construction work, always keep a
Brunton Pocket Transit handy.

BRUNTON *is a registered trade mark of*

WM. AINSWORTH & SONS, INC.
2151 LAWRENCE ST. • DENVER 2, COLORADO
OVER 40,000 SINCE 1896

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- House Foundations
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- Schools

So light a child can lift them

CHECK COUPON FOR LABOR DATA

IRVINGTON FORM & TANK CORP.
Irvington, N. Y.

☐ Send Labor Data.
Send more information. I am interested in forms for________
Name________
Firm________
Address________

Equipment, Materials & Methods (Continued)

hidden beneath the splash pan in front of the car. Additional pushbutton controls can also be placed in the garage or house, and a key operated switch can be located outside the garage. A feature of the device is that it automatically turns on garage lights as the door is opened, and turns them off again when the door is closed. Installation is very simple. No more headroom is required above the door than for ordinary manual operation. The complete package includes all necessary parts except one length of two-by-four used to attach the motor unit to the top of the door. Wiring is simple; the installed unit plugs into any 110-volt, 60-cycle outlet in single-phase, alternating current circuits. The device can also be wired to turn other lights on and off, inside or outside the home or garage. The dashboard control is easily transferred from one car to another, and more than one car can be equipped to operate the door, if desired. Mr. J. S. Poorman **Kinnear Mfg. Co., Columbus 16, Ohio.**

Electric Cable Hoists

A LINE OF HEAVY-DUTY ELECTRIC CABLE HOISTS manufactured in 1/2, 1, 1 1/2, 2, 3 and 5 ton capacities is announced. An outstanding feature of the Bob-Cat hoist line is its total enclosure of the motor within the cable drum. This greatly reduces over-all dimensions and affords substantial weight savings by comparison with hoists that employ conventional external type overhanging motors. Due to the enclosed hoist design, motors are completely protected against moisture, splashing liquids, weather, dust and corrosive atmospheres. Hoists are powered by high torque Ohio motors specially manufactured for use with Bob-Cat units. Gear reduction is by means of a double internal (epicyclic) gear train that incorporates two Weston-type load brakes. Motor brake is of the equalizing solenoid type connected to an up-limit cutoff switch. All load-lifting and carrying parts are made of steel forgings and castings. Safety factor is in excess of 6 to 1. Load hook oscillates on ball bearings and swivels on roller bearings. It is suspended on a 5/16 in. preformed plow-steel cable. Hook can be replaced without dismantling any part of hoist. Designed for operation on 220, 380, 440, or 550-volt 3-phase, 60-cycle current, Bob-Cats are available with either pendant rope control or push-button control on pendant cable. The latter style has a strain relief cable from the hoist to the control. A transformer in the electrical supply line cuts voltage at the control to 110 volts. **The Cleveland Chain & Mfg. Co., Broadway and Henry Sts., Cleveland 5, Ohio.**

When Requesting Literature, Please Tell The Manufacturers You Saw Their Products Mentioned in Civil Engineering

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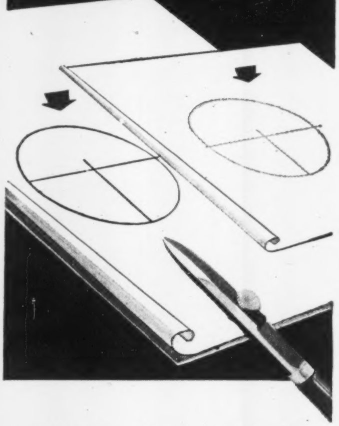

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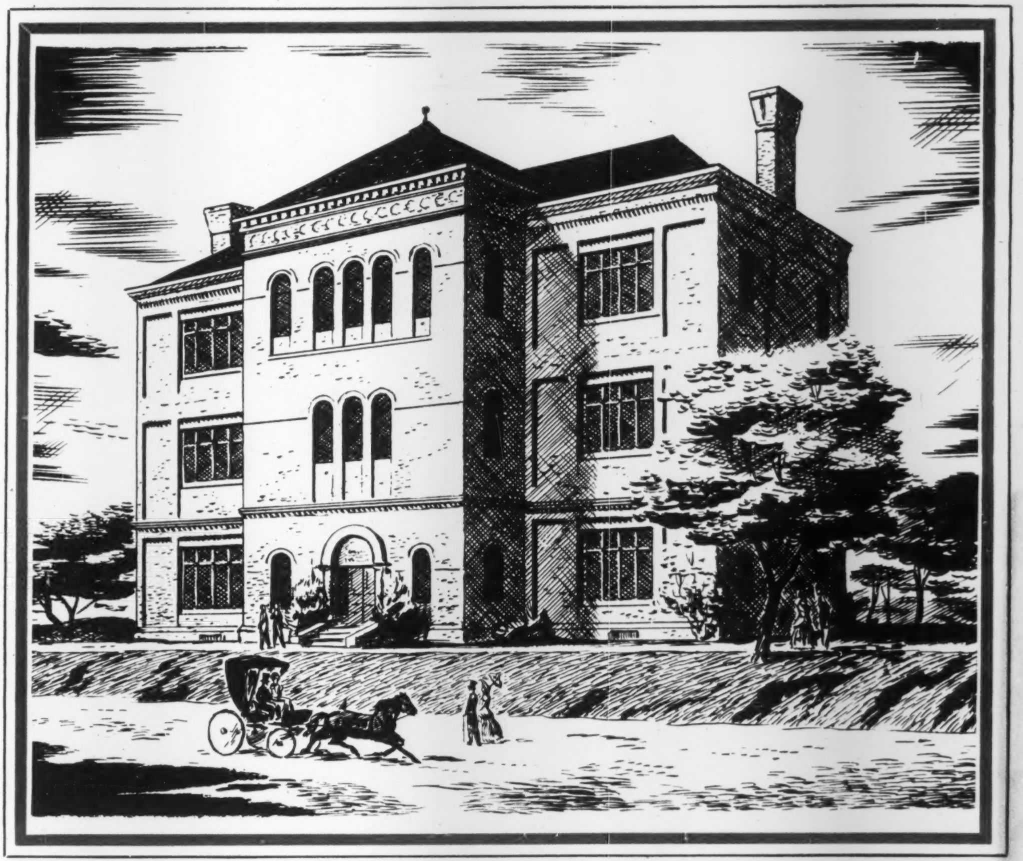

Troy's Rensselaer Polytechnic Institute as it looked 100 years ago

Troy, New York, has a cast iron water main in service that was installed more than a century ago, not long after the founding of Rensselaer Polytechnic Institute, one of America's oldest schools of science. An engineer of that day, who could foresee the transition from horse-drawn vehicles to buses and ten-ton trucks, would have been bold indeed to predict a useful life of 100 years for a cast iron underground main. Yet that is the record of cast iron pipe in numerous cities in spite of the changes in a century, and the stresses imposed by modern conditions of traffic and congested underground services.

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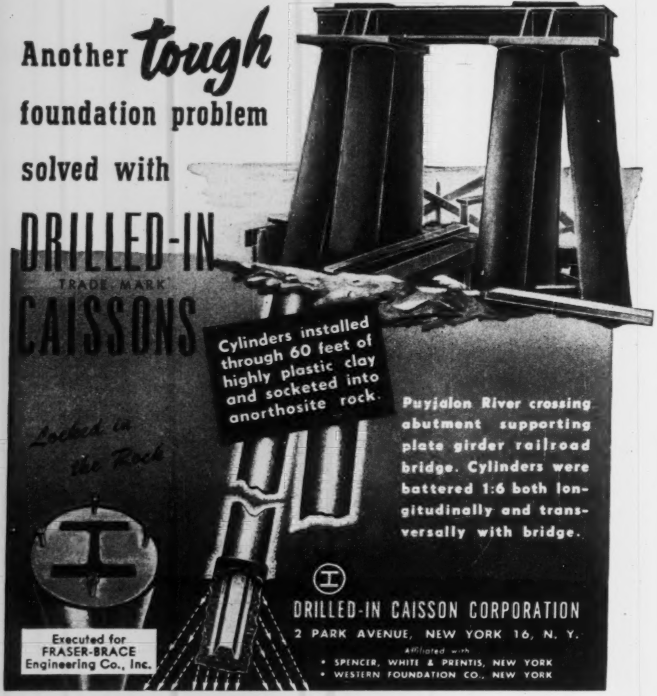
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Puyjalon River crossing abutment supporting plate girder railroad bridge. Cylinders were battered 1:6 both longitudinally and transversally with bridge.

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CEMENT GUN CO. RESTORES BRIDGE

Photo above shows the disintegrated condition of an abutment on a reinforced concrete bridge in a large Western Pennsylvania city. Repair work on this structure necessitated an almost complete rebuilding of the abutment. To accomplish this, the end span was jacked up and new expansion plates were placed at the bridge seats. In addition to repair of abutments—beams, girders, and arch ribs were reintegrated with "GUNITE" wherever disintegration had taken place.

This is just one of many typical "GUNITE" repair jobs which have been done by our contract department for Railroads and State Highway Departments throughout the country. For information on "your job" and description of many other "GUNITE" jobs performed by us send details and request catalog A2400—on your letterhead, please.

CEMENT GUN COMPANY
"GUNITE" CONTRACTORS
GENERAL OFFICES—ALLENTOWN, PENNA., U.S.A.

MANUFACTURERS OF THE CEMENT GUN

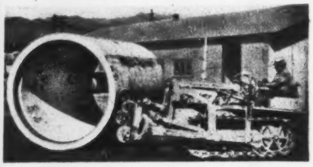
Equipment, Materials & Methods (Continued)

Heavy Duty Caster

Full-scale production of heavy duty casters for pneumatic industrial wheels is announced. The caster was developed in answer to urgent demands for industrial casters that would move maximum loads with a minimum of vibration and shock. To fulfill explosives plant safety requirements, the caster is sparkproof and generates minimum friction heat due to rollability guaranteed to be 20 percent greater than that of ordinary industrial casters. As a further safety factor, the caster incorporates cased bearings which are said to eliminate the race wear common with ordinary ball bearings. Available as a mounting for 10 in. diameter pneumatic wheels, the caster has designed load rating of 1200 lbs. It retains all of the utility and maintenance features of Aerol's small casters despite its heavy-duty construction. **Aerol Co., Inc., 2820 Ontario St., Burbank, Calif.**

Roller Device

Maneuvering 21-ton concrete pipe sections around is no trick at all if you are properly equipped. The Hawaiian Dredging Company solved the problem on the San Island Sewer Outfall job by using a



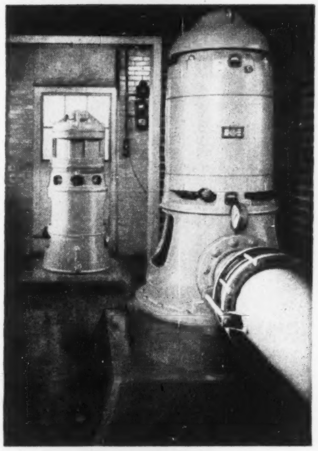
Pipe Roller

Caterpillar diesel tractor with a special device which consists of hard rubber rollers applied to a bulldozer blade. Pipe sections as big as 84 in. in diameter are shoved about by this unique pushing arrangement. **Caterpillar Tractor Co., Peoria 8, Ill.**

Generators

An addition to the G-E Tri-Clad motor and generator family has been announced. Available in four basic designs, the Tri-Clad high-speed synchronous generators have ratings from 1.875 to 50 kva. Designated as types ATI, ASI, and ATB, the generators have frequency ratings of 60 and 400 cycles. Three standard types of 60 cycle generators are offered, providing a range of characteristics for several different categories of voltage regulation and motor starting requirements. Variations of the basic machines are available with special characteristics for special applications. The basic 60 cycle design is an externally regulated generator designed to operate with standard voltage regulator in the exciter field circuit. Standard excitation voltage is 64 volts but equipments suitable for 125 volts excitation are

(*Continued on page 91*)



BEATRICE, NEBRASKA

UPS WATER SUPPLY

With a Layne Short Setting Booster Pump

From four Layne Well Water Units, Beatrice, Nebraska was putting 1600 gallons of water per minute into the city through their six miles of 14 inch mains. Growth of population and new industries created a need for more. The problem was easily, quickly and economically solved by installing a Layne Short Setting Booster Pump in line with the wells. As a result, water supply was increased to 2,380 gallons per minute—nearly 41 percent.

The Layne 2-stage, 15 inch bowl booster pump, powered with a 100 H.P. motor was easily accommodated in a small pump house addition, thus saving the cost of extra heating equipment. Installed in 1948, it is giving highly satisfactory service.

These Layne Short Setting booster pumps may be used by other cities—and factories as a means of increasing water supply at a very nominal cost.

If you are in need of more water either from your present wells, or from new units, Layne engineers will gladly survey your present equipment and make dependable recommendations. For further information, catalogs, etc. address

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VERTICAL TURBINE PUMPS

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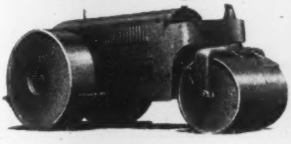
Equipment, Materials & Methods (Continued)

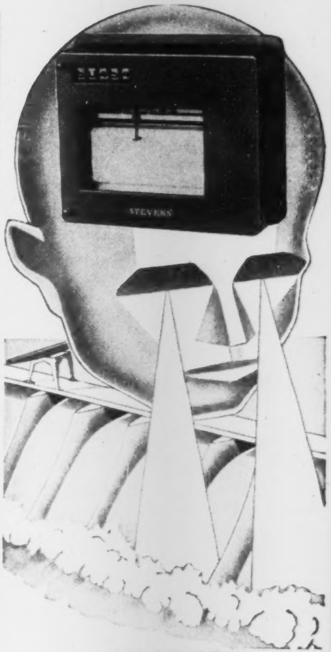
available. Ratings at 60 cycles vary from 2 kw, single phase to 15 kw, 3 phase. A modification of the basic 60 cycle line provides self regulated features for applications where average voltage regulation and motor starting ability is desired. Voltage regulation of 12 per cent at 0.8 pf with 3 phase loads is obtained by special saturated magnetic circuit design, together with overhung exciter for stiff excitation source. Ratings are available in the range 1 kw, single phase to 10 kw, 3 phase. The third 60 cycle line involves the basic 60 cycle generator, and a special overhung amplidyne exciter, and a static voltage regulator, all wrapped in one package. This line is applicable where close voltage regulation and excellent motor starting ability is required. Regulation is plus or minus 2 per cent at rated 0.8 pf. The high-frequency, 14-pole, synchronous generator is the 4th design in the line. Suitable for applications which require 400 cycle power, the 14-pole unit is designed for military ground power engine—or motor-generator sets, testing laboratories, textile mills, etc. The units are also applicable in frequency changer equipments driven by 3500-rpm motors. These are available in ratings 2 kw, single phase through 40 kw, 3 phase at 3428 rpm. **General Electric Co., Schenectady 5, N. Y.**

Variable Weight Roller

THE VARIABLE WEIGHT "Chief" three-wheel roller, is offered in a complete range of sizes from six to twelve ton weights inclusive. The Chief is available in ten and twelve ton (unballasted) weights—either of which can be equipped with 20 in. or 24 in. width rear rolls. The steel drum rolls can be filled with water ballast to obtain a wide range of compression weights varying from two to three additional tons—depending on the size of roller. According to the specifications, the ballast type rolls are fabricated from heavy steel plate, electric welded, and have machine finished surfaces. They can be supplied with mats and sprinklers for use on finishing work as well as primary compaction jobs. The Chief has an extra-rugged transmission and spur gear final drive, cab-controlled differential lock, heavy-duty clutches, hydraulic steering, and heavy-duty gasoline or diesel engine. **The Galion Iron Works & Mfg. Co., Galion, Ohio.**



The Chief



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Equipment, Materials & Methods (Continued)

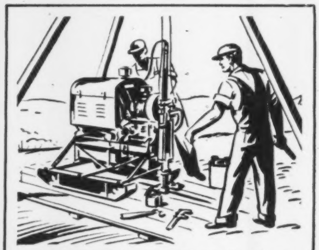
Stabilizer

A SMALLER MODEL single pass soil stabilizer is announced. The machine, the Model EA-56, is designed to make the P & H method of processing stabilized base available for all projects, regardless of size. A smaller version of the 8 and 10 ft stabilizers, the machine processes a 5 ft width. It can be used for all types of stabilized base construction, including soil cement, cement treated base, various combinations of cut-back asphalt, asphalt emulsions or tar with soil, sand or aggregates and mechanical and chemical stabilization. The 5 ft processing width offers advantages on smaller roadway, street, alley, parking strip, and other jobs. On larger projects, two or more stabilizers may be used. The single pass stabilizer is self-propelled and performs all necessary operations for complete processing of in-place soils with any type admixture, leaving the materials ready for compaction. It processes in a single pass at a high rate of production and requires just one operator. Ask for Bulletin S-9, **Harnischfeger Corp., 4400 W. National Ave., Milwaukee 14, Wis.**

Model EA-56

Trucks

TRUCKS FOR 1950, including more than 180 models designed to reduce operating costs, make trucks adaptable to more jobs and to add driver convenience and comfort, have been introduced. The trucks feature automatic power pilot carburetion-ignition control on all engines. The system provides power with economy by metering and firing the correct amount of fuel at the right instant under varying loads without spark knock. The cab and front end have been restyled to give a more rugged and smarter appearance. The rear window was redesigned and enlarged to more than 3½ ft for full range vision. An instrument panel incorporates full-vision instruments, rheostat type instrument light switch and a hand throttle on all conventional models. Engines have been improved to reduce operating costs and make them quieter. All now have chrome top piston rings, autothermic expansion control pistons and new high-lift camshafts. **Ford Motor Co., 3000 Schaefer Rd., Dearborn, Mich.**



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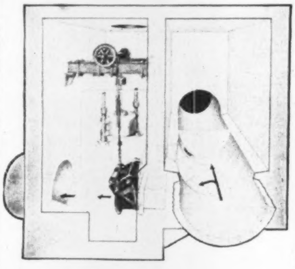

Fig. B-19

Automatic Sewage Regulators control sewage flows either by partially or completely cutting off such flows to suit head or tail water conditions or by "governing" to discharge a predetermined quantity regardless of head or tail water conditions.

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Literature Available

WATER METERS—Accurate auto-stop water meters, which automatically control the amount of water delivered to ready-mix concrete batches, are described in Bulletin 562, just released. Covering 1 in., $1^1/_2$ in., and 2 in. meters for cold, warm or hot water, this bulletin gives complete specifications and prices. **Neptune Meter Co., 50 W. 50th St., New York 20, N. Y.**

CRANE-EXCAVATORS—A 14-page catalog, illustrating in color the heavy-duty line of $^1/_2$ yd crane-excavators, has been published. Numerous "money-making" features of all three models—crawler, truck and wagon—are shown in this descriptive catalog. These include the deck machinery layout, self-leveling chassis, oversize 20 in. clutches, large modern cab and right angle drive mechanism. Complete specifications and operating data are included. **Wayne Crane Div., American Steel Dredge Co., Inc., Fort Wayne, Indiana.**

DIESEL ENGINES—A catalog describing the complete line of Series 71 2-cycle diesel engines for application in the industrial, petroleum and marine fields is announced. The book covers single and multiple engine units from 2 to 24 cylinders with power ranging from 32 continuous to 780 intermittent horsepower. It contains data on GM diesel 2-cycle designed and interchangeability of parts; a "Select Your Power" chart covering 57 standard power take-off and 7 torque converter models; engine illustrations and an outline of Detroit diesel service facilities. **Detroit Diesel Engine Div., Adv. Dept., 13402 West Outer Drive, Detroit 28, Mich.**

MACHINERY—All types of machinery manufactured by the company are contained in the 28-page, two color bulletin just published. Fully illustrated with installation and product photographs, Bulletin 187 also gives design data on two and four-cycle stationary and marine diesel engines, gasoline marine engines, Symons cone crushers and screens, mine hoists, machinery for the basic processing of ores and minerals, air and gas compressors and railway track maintenance equipment. Various industrial applications of this machinery are also contained in this bulletin. **Nordberg Mfg. Co., Milwaukee 7, Wis.**

AIR COMPRESSOR DRIVES—Up-to-date information on motor drives for all types of large air compressors is supplied in the new issue of the E-M Synchronizer, No. 32. The two-color, 24-page bulletin is fully illustrated and contains a wealth of tables, charts, and graphs for matching motor characteristics to compressor requirements. Also contained in this informative issue is a technical discussion of "P_r," "Synchronizing Power," the various methods of motor and control protection for compressor installations, and an interesting sidelight to the compressor industry in an article dealing with the glass industry—one of the foremost users of compressed air. **Electric Machinery Mfg. Co., Minneapolis 13, Minn.**

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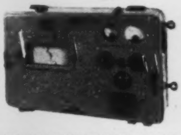

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Literature Available (Continued)

DRILLING EQUIPMENT—A 4-page bulletin presents in condensed form the complete line of drilling equipment developed during the past 30 years. Write for Bulletin 33. **Acker Drill Co., Inc., Scranton, Pa.**

PRESTRESSED PIPE—A 4-page booklet tells how prestressed concrete steel-cylinder is made, and shows its advantages. Of particular interest is the explanation of how the steel cylinder and concrete core are prestressed to form an elastic structure, and how the pipe handles high pressures with a minimum of stress. **Price Brothers Co., 1932 E. Monument Ave., Dayton, Ohio.**

WATER PRESSURE REDUCING VALVE—A 6-page bulletin containing complete technical information on the cushioned water pressure reducing valve is now available. The installation, operation, adjustment, servicing and specifications are fully described, along with tables showing general dimensions, approximate shipping weights and general list of materials. Bulletin No. W-3 may be obtained from **Golden-Anderson Valve Speciality Co., 2102 Keenan Bldg., Pittsburgh 22, Pa.**

CONVEYOR AND ELEVATOR BELTS—A 26-page catalog section features illustrations which portray in detail all major parts used in construction of a line of conveyor and elevator belts. The publication describes all belt features, explains why increased service life with decreased maintenance are made possible by the construction and tells the function which each part of the belt performs, as well as significant data on each belt in the company's line. **The B. F. Goodrich Co., Akron, Ohio.**

CLAMSHELL BUCKETS—A colorful 8-page catalog recently prepared, describes the merits of all-welded clamshell buckets. A full page is devoted to a complete table of condensed specifications, listing the details of capacity, weight, dimensions, sheave and cable data for each size and type of clamshell. Action photographs of the buckets are also included along with a summary of the manufacturer's complete line of concrete batching and cement handling equipment. Copies of the bulletin may be obtained by writing to **C. S. Johnson Co., Champaign, Ill.**

CRAWLER TRACTORS—Two attractive 16-page catalogs, each telling the story of a new crawler tractor, have just been issued. One describes the Model HD-9, the other covers the Model HD-15. Each catalog utilizes double-page spreads to discuss major features of the tractors. Both make extensive use of large illustrations of the two units and their components. Captions give tractor buyers the information they want quickly and concisely. Complete specifications, plus details of allied equipment and special accessories are also included. **Allis-Chalmers Tractor Div., Milwaukee 1, Wis.**

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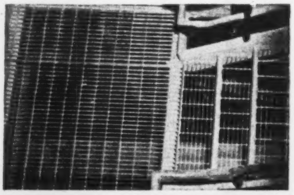

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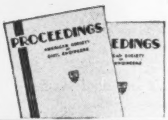

PROCEEDINGS AVAILABLE

THE FOLLOWING PAPERS, printed as Proceedings Separates, may be ordered on the basis of summaries given in this and previous issues of CIVIL ENGINEERING. Discussions of these papers will be received, as in the past, for a period of five months following the date of issue. A summary of each paper appears in several consecutive issues; other titles will be added every month, as they become available. Use the convenient order form on page 96.

Summarized in Earlier Issues

35. **Design Curves for Footings on Soil,** by Winfield A. McCracken.

D-XXII. Discussion of Paper, **Analytical Method of Determining the Length of Transition Spiral,** by Michael V. Smirnoff.

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36. **Impossibility of Performance in Contracts for Engineering and Construction,** by Robert F. Borg.

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46. **Human Aspects of Mexican Irrigation,** by Antonio Rodríquez Langoné.

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48. **Compaction of Cohesive Soils:** Progress Report of the Subcommittee on Consolidation of Materials in Earth Dams and Their Foundations of the Committee on Earth Dams of the Soil Mechanics and Foundations Division.

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Third Notice

51. **Laterally Loaded Plane Structures and Structures Curved in Space,** by Frank Baron and James P. Michalos.

52. **Some Aspects of Electronic Surveying,** by Carl I. Aslakson. Surveying and mapping techniques are undergoing revolutionary modifications as the result of advances in electronics. Commander Aslakson, who has been actively engaged in the development of long distance electronic measuring techniques since 1944, discusses these changes. Commander Aslakson recently reported a new measurement of the velocity of radio waves by long distance electronic measurements. His value has recently been offered by British and Swedish scientists as corroboration for adoption of a new velocity of light which is about 1 part in 20,000 higher than the previously accepted value. He also reports that such rapid advances in accuracy are being made that publication dates cannot keep pace with developments. (Available February 1.)

53. **Wedge-Beam Framing,** by Arsham Amirikian. Wedge-shaped members, having tapered flanges and webs, constitute elements of a new type of framing. These members are joined by an alternating series of rigid and flexible connections to form assemblies which provide appreciable economies and lend themselves to a simple analysis. The paper contains suggested arrangements of framing, details of connection and a method of analysis. As an aid in design, the analysis is reduced to the formulation of a series of simultaneous equations involving a limited number of redundants, which are set directly, through tabular guides, and their solution is obtained by a simplified procedure. (Available February 1.)

54. **Truss Deflections by the Coordinate Method,** by Kuang-Han Chu. The method described in the paper is an algebraic equivalent of the Williot-Mohr diagram. By adopting a set of simple sign conventions and by suitable arrangement in tabular forms, the work is minimized. This method, like the Williot-Mohr method, is in many respects superior to many available algebraic methods for determining truss deflections as it determines both vertical and horizontal components of the movements of all joints in a truss. Moreover, it is preferable to the graphical Williot-Mohr method in that it can be carried to any degree of accuracy. (Available February 1.)

55. **Measurement of Sedimentation in Small Reservoirs,** by L. C. Gottschalk. The standard field practices of the Soil Conservation Service, in the assembly of sedimentation data, are described. Equipment and methods of sounding for water depths and silt thicknesses are given, and surveying procedures discussed. This paper should be considered

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as a companion to Separate No. 50, "Supersonic Sounding Instruments and Methods," by Joseph M. Caldwell. (Available February 1.)

Second Notice

56. Turbulent Transfer Mechanism and Suspended Sediment in Closed Channels, by Hassan M. Ismail. The relation between momentum transfer and sediment transfer in smooth, closed rectangular channels was studied. Application of this relation makes possible evaluation of momentum transfer coefficients at the central region of the channel using direct suspended load measurements. The paper describes the effect of sand in suspension on the universal constant of turbulent exchange, distribution of momentum transfer coefficient and the coefficient of friction. (Available March 1.)

57. Design of Irrigation Systems, by W. H. Nalder. An account of the planning and design considerations entering into the development of irrigation features of multiple-purpose projects of the Bureau of Reclamation is presented. Reviewed are the major factors affecting irrigation development and their attendant engineering implications, the elements of an irrigation system, and the influence of economics on design. The principal features of three Reclamation multiple-purpose projects are described. (Available March 1.)

58. Highway Planning in Turkey, by H. E. Hilts. Engineering activity in Turkey as a result of United States assistance, under the "Point Four" program, is recorded. The problem involves highway improvements in a nation somewhat larger than the State of Texas comprising 12,500 miles of national highways, 13,500 miles of provincial roads, and about 62,500 miles of city streets, village streets, and rural roads. The paper outlines preliminary organizational and planning details. (Available March 1.)

59. Limit Design of Beams and Frames, by H. J. Greenberg and W. Prager. A method of limit design of statically indeterminate beams or frames under load is presented. The limit moments under which individual sections act as hinges are presumed known throughout the structure, and a safety factor against collapse is sought. Two extremum principles for this factor are established. (Available March 1.)

60. Surveying and Mapping Requirements for Modern City Planning, by Charles A. Blessing. An outline of the need for reasonable standardization of mapping and surveying procedures by the city-planning commissions in all cities, large and small is presented. The paper suggests map types and scales which have been found useful in a number of cities and proposes a revision of ASCE Manual No. 10 to include a more definite statement of surveying and mapping requirements for modern city planning from the point of view of the city planner, who is the user of the survey. (Available March 1.)

D-7. Discussion of Paper, **The Geochemistry of Earthwork,** by Hyde Forbes. The original paper, published in March 1950, presented observational and test data relative to the geochemical processes and the mineralogical changes set up in working with earth, in excavations and in engineering structures. Discussers are: Warren D. Smith, D. P. Krynine, S. S. Gorman, Charles H. Lee, George S. Harman, and Hyde Forbes. (Available March 1.)

D-XXV. Discussion of Paper, **Numerical Computation of Buckling Loads by Finite Differences,** by Mario G. Salvadori. The original paper, published in December 1949, explained the buckling problems that may be obtained by purely numerical computations, using a procedure of successive approximation. Discussers are: I. K. Silverman, Bruno A. Boley, G. R. Ramaswamy, Chi-Teh Wang, George Hermann, and Mario G. Salvadori. (Available March 1.)

First Notice

61. Structural Damping in Suspension Bridges, by the late Friedrich Bleich and L. W. Teller. In three parts, this paper comprises (1) a theoretical study of damping capacity of suspension bridges resulting from internal friction and from various sources of dry or Coulomb friction in the structure, (2) an account of an extensive laboratory study of frictional damping in structural members, and (3) a correlation of the theory with experimental data. (Available April 1.)

62. The New Towns Program in Great Britain, by T. C. Coote. Fourteen new towns are now under construction in Great Britain. Two are in Scotland, eleven in England, and one in Wales. These new towns are being erected by development corporations which employ their own technical staffs or outside consultants. Construction work is gathering momentum, and in each of the earlier established new towns it is planned to erect about 1,000 houses, together with some factories and shops. Extensive civil engineering works are being undertaken to open up the sites. (Available April 1.)

63. National Geodesy—Status and Planning, by Leo Otis Colbert. From its inception, the United States Coast and Geodetic Survey has been engaged in establishing the horizontal and vertical controls necessary as a base for land surveys and engineering projects. The paper describes the development of the geodetic network, the status of control surveys, and the scheduling of future geodetic work. The role of the engineer in preserving existing reference points is emphasized. (Available April 1.)

D-8. Discussion of Paper, **Floating Tunnel for Long Water Crossings,** by Charles E. Andrew. The original paper, published in March 1950, outlined a study of possible methods, if any, of constructing a permanent highway structure across Puget Sound between Seattle, Wash., on the east and the mainland on the west shore. Discussers are: Robert S. Mayo, Homer M. Hadley, and Charles E. Andrew. (Available April 1.)

D-11. Discussion of Paper, **Long-Term Storage Capacity of Reservoirs,** by H. E. Hurst. The original paper, published in April 1950, presented a solution of the problem of determining the reservoir storage required on a given stream to guarantee a given draft. Discussers are: Ven Te Chow, Henri Milleret, Louis M. Laushey, and H. E. Hurst. (Available April 1.)

D-16. Discussion of Paper, **Pavement Bearing Capacity Computed by Theory of Layered Systems,** by Guthlac Wilson and G. M. J. Williams. The original paper, published in May 1950, described a method for calculating the bearing capacity of rigid and flexible pavements, which was based on the theory of layered elastic systems. Discussers are: Robert Ruckli, Hugh Q. Golder, and Guthlac Wilson and G. M. J. Williams. (Available April 1.)

D-19. Discussion of Paper, **Flood-Control Operation of Tennessee Valley Authority Reservoirs,** by Edward J. Rutter. This original paper, published in May 1950, discussed the actual flood conditions and actual and alternative hypothetical operations of the tributary and main-river reservoirs during these floods. Discussers are: Ray K. Linsley, Jr., and Edward J. Rutter. (Available April 1.)

D-23. Discussion of Paper, **Influence of Heavy Loads on Pavement Design Trends,** by K. B. Woods. The original paper, published in June 1950, developed the design of highway pavements through extensive use of test roads, the use of theoretical or rational procedures, and by the combined experiences of many highway engineers over a considerable period of time. Discussers are: William S. Pollard, Jr. and K. B. Woods. (Available April 1.)

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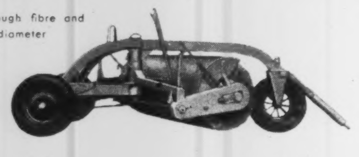

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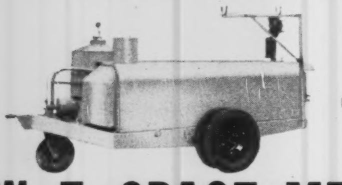

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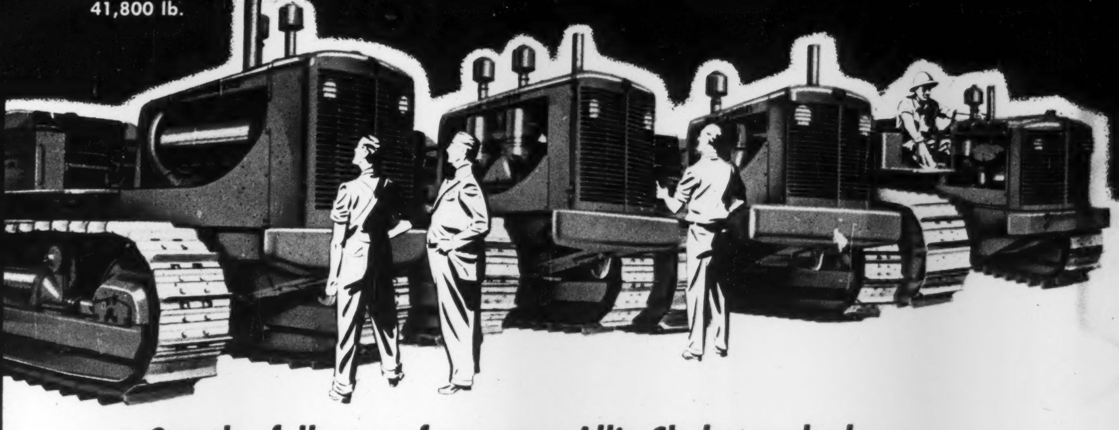

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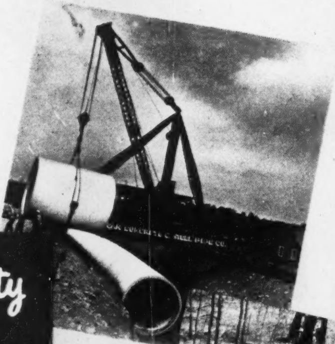

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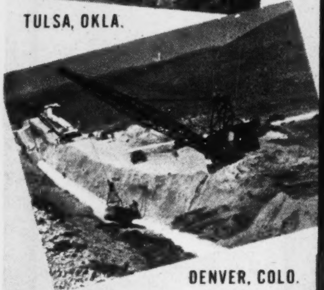

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